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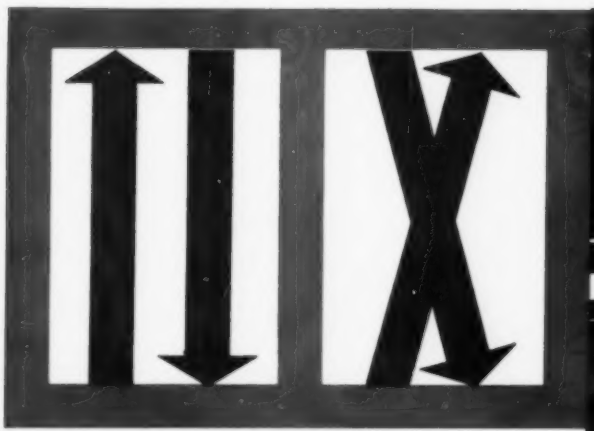
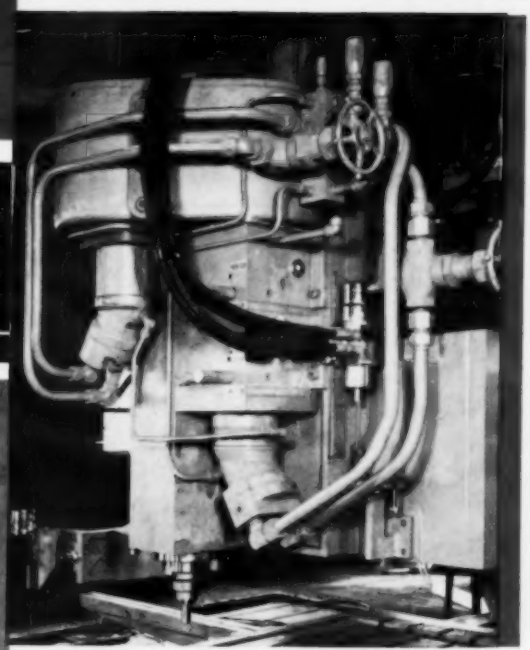
FEBRUARY 1961



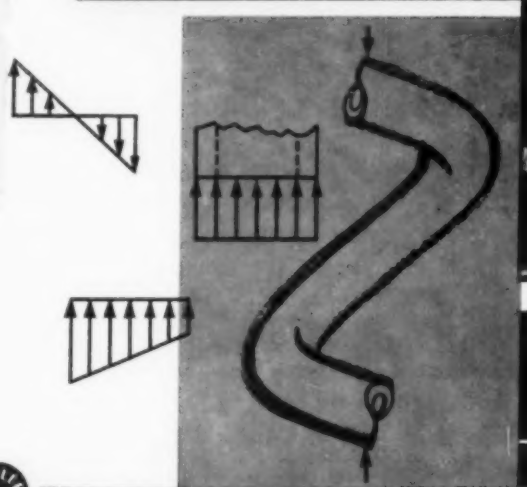
A Course in Hydraulic Valves

PART 1

Directional Control Valves



Designing Hydraulic Spindle Drives



Why Tubing Fails

313 NORTH FIRST

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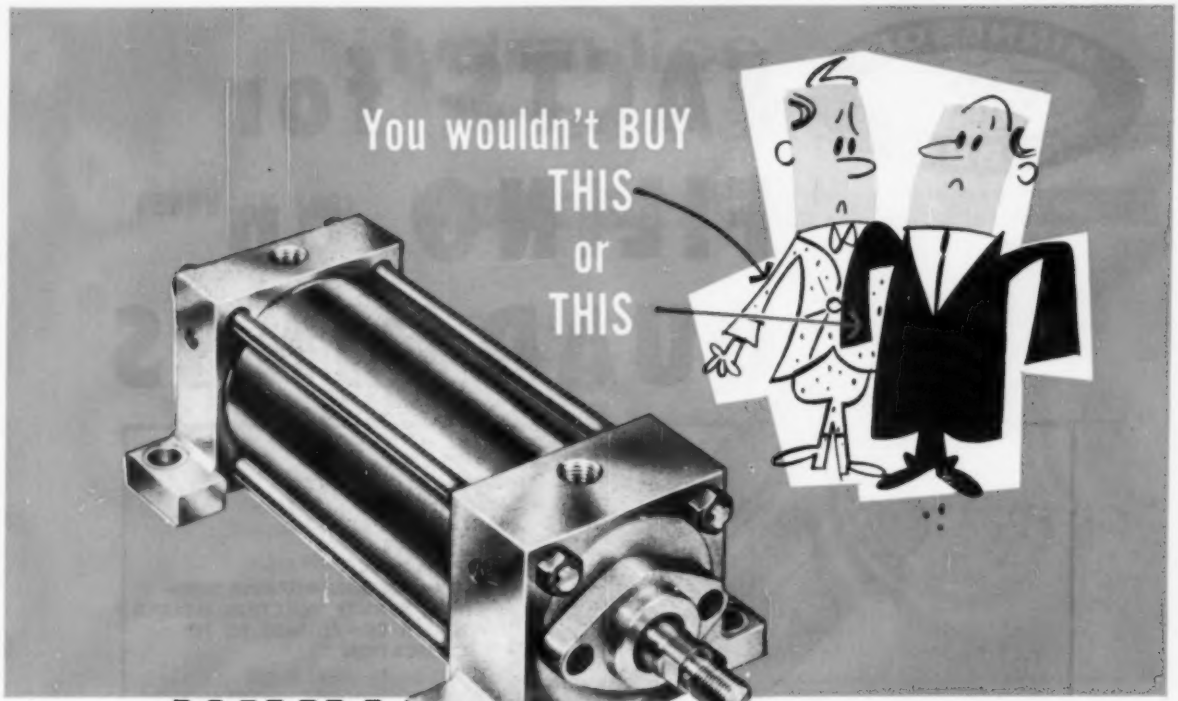

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Hydraulics & Pneumatics

VOLUME 14/NUMBER 2

FEBRUARY 1961

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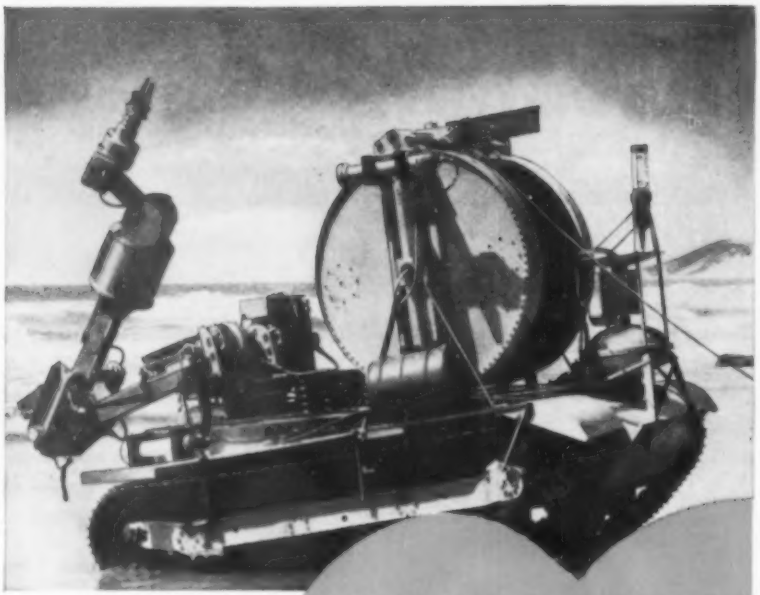

REMOTE UNDERWATER MANIPULATOR BUILT FOR THE U. S. NAVY BY THE SCRIPPS INSTITUTION OF OCEANOGRAPHY OF THE UNIVERSITY OF CALIFORNIA AND THE HUDSON LABORATORIES OF COLUMBIA UNIVERSITY.

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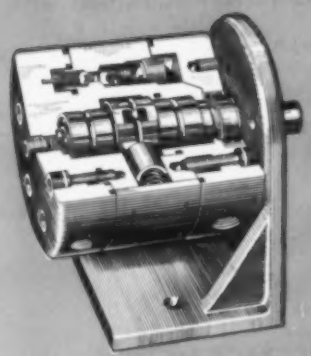

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COMPREHENSIVE NO. 403 CATALOG SHOWS ANCHOR "O" RING FLANGED HEAD HYDRAULIC HOSE ASSEMBLIES, CLAMP TYPE COUPLINGS, HOSE and WELD FITTINGS

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Anchor Clamp Type Couplings for Three Heavy Wire, Two Wire, Two Heavy Wire, One Wire, Hi-Burst Two Rayon, standard Two Rayon and Suction Return Spiral Wire Hose are also described.

Specifications and valuable data on Anchor Weld Fittings for new flexibility and versatility in use of pipe and tubing in hydraulic transmission lines cover Elbow Weld, "O" Ring Flanged Head Weld, Saddle Weld, Socket Weld, Split-Flange Halves and Components, Tank-Pilot Weld, Tee Weld, Weld Pipe Plugs, etc.

Of special interest are the newest, up-to-date SAE dimensions for Industrial Hydraulic Flanged Tube, Pipe and Hose Connections—Four Bolt Split-Flange Type, and Port Dimensions for Bolted Flange connections. An Anchor *"first"*, the designs for these Anchor products have set the standard for the industry.

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FLUID POWER LINES

about hydraulics & pneumatics

KNOW YOUR VALVES . . . Much of a designer's skill in designing hydraulic circuits depends on his knowledge of valves. Understanding what types are available, what their design features are, and how they work is the basis for working out the most effective systems at lowest cost.

Starting in this issue, HYDRAULICS & PNEUMATICS presents a course in hydraulic valves. The subject will be covered in three articles. The first one on directional control valves starts on page 55. The series is a comprehensive and basic study of valves, and the examples are intended to show representative types rather than features of a particular make. The information in these articles will give a general background to understand specifications and advantages explained in manufacturers' literature.

The charts, which are part of each article in the series, relate symbols to valve construction and function. They will be handy references in designing circuits. Following the ASA rules on drawing symbols which are given in the article will help standardize your drawings and give you a common "vocabulary" with other fluid power engineers.

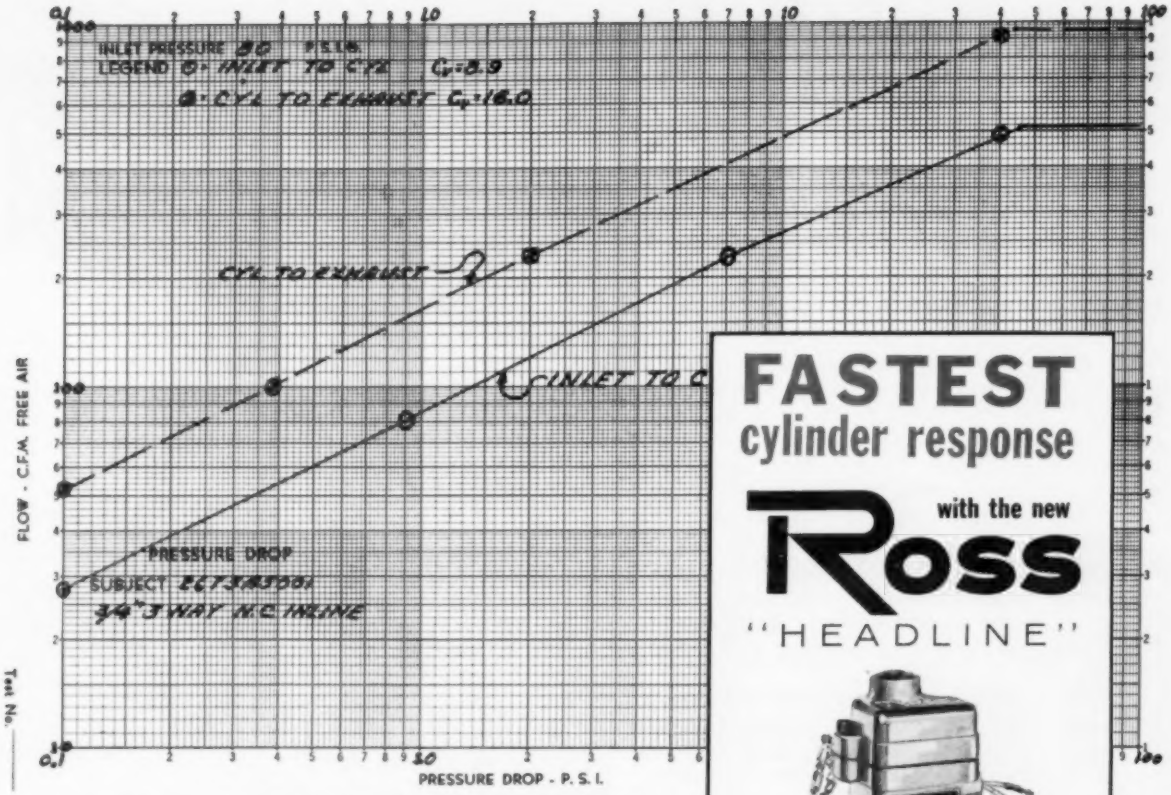
POWER FOR SPACE CRAFT . . . One of the primary concerns of space craft designers is to provide power for functions other than propulsion. Hydraulic, pneumatic, and electrical systems will all be useful, depending on vehicle size, its power requirements, and its other subsystems. Lockheed's Charlie Cannon reviews present thinking in his article *Trends in Secondary Power Systems.* It's in this month's Aerospace Section.

HYDRAULIC HARVESTING . . . Surviving competition from hundreds of competitive preparations, the castor bean, and its therapeutic oil, still keeps its hallowed place in medicine. To harvest the beans, Hopper Machine Works in California has developed a machine which picks, cleans, and collects the beans in a bin. The operations, which are all powered by fluid motors, are described on page 80.

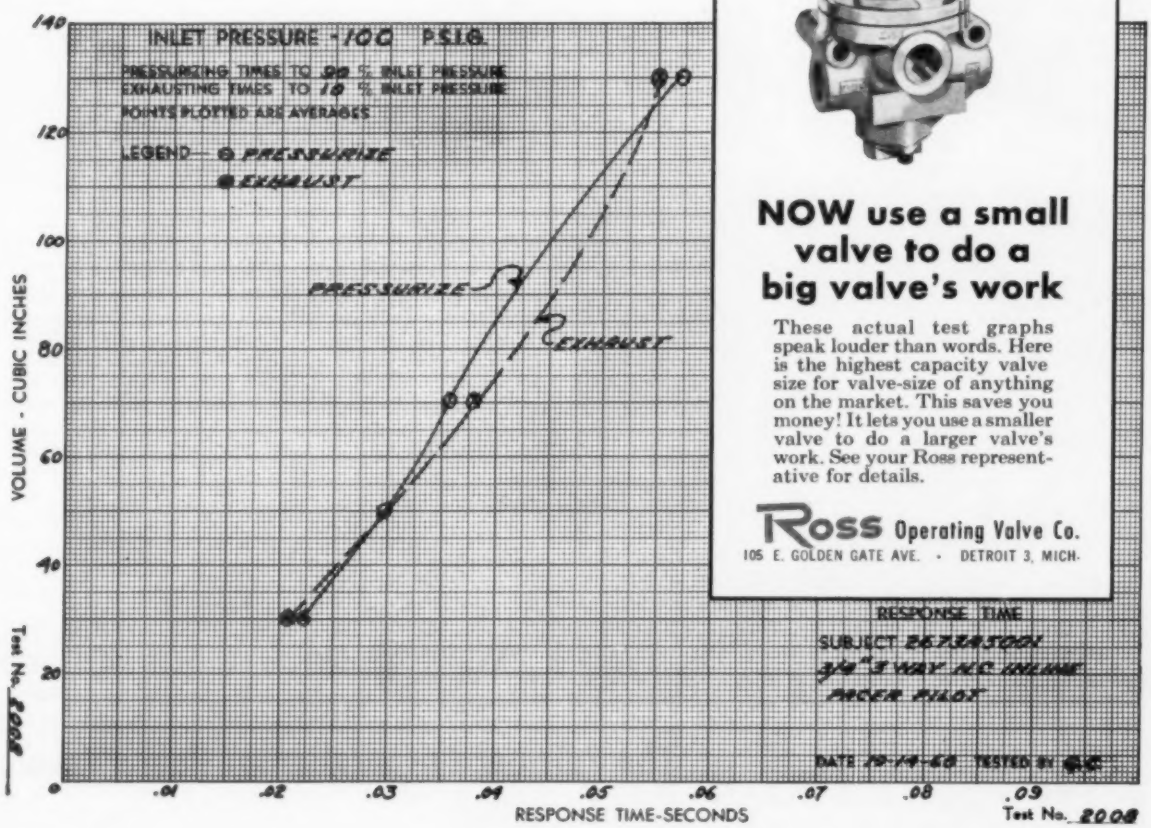
NEW MILL STREAM . . . Among other blossoming applications for hydrostatic drives (mostly on mobile equipment) two fluid-powered milling machines are discussed in *Designing Hydraulic Spindle Drives.* Again the variable volume motor sports its inherent advantage—constant horsepower by changing displacement, so torque and speed vary inversely. This is just what's needed in milling and most other machining.

CAUSE AND EFFECT . . . Leakage isn't a disease, it's a symptom. Oil on the floor should tell you to analyze machine construction, design, usage to find out *why* it's a leaker. One of the first things to look for is improper support of lines and vibration. For the theory on why tubing fails see page 66.

STOPPING A ROCKET . . . Riding along a single rail, a rocket sled developed by Norair speeds to 2700 mph in 2 seconds. To spot it, drag fins swing out to create wind resistance. A snubbing cylinder takes up the shock as the doors swing out. Design of the snubber is explained in Fred Henry's article, *Braking a Rocket Sled.*


INLET PRESSURE 80 P.S.I.G.
LEGEND ⊙ = INLET TO CYL C_v=8.9
● = CYL TO EXHAUST C_v=16.0
CYL TO EXHAUST
INLET TO C
PRESSURE DROP
SUBJECT 26T3R3T001
3/4" 3 WAY N.C. INLINE
FLOW - C.F.M. FREE AIR
Test No.
PRESSURE DROP - P. S. I.

These graphs represent one series of tests with a random selected valve under specific conditions of pressure, temperature, humidity, fluid flow and voltage.



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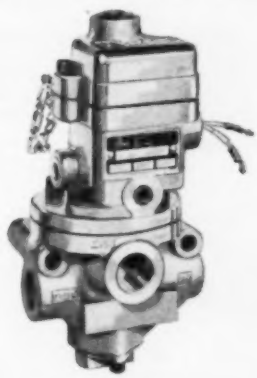
"HEADLINE"



NOW use a small valve to do a big valve's work

These actual test graphs speak louder than words. Here is the highest capacity valve size for valve-size of anything on the market. This saves you money! It lets you use a smaller valve to do a larger valve's work. See your Ross representative for details.

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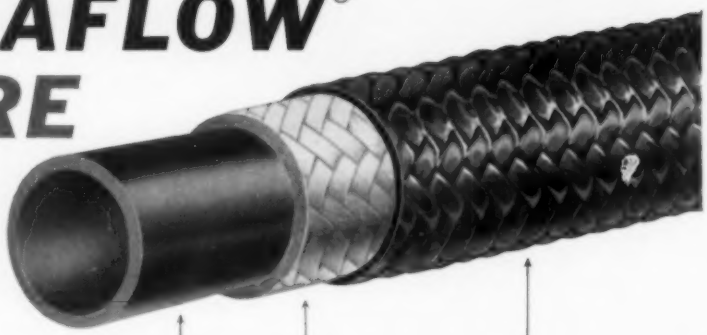

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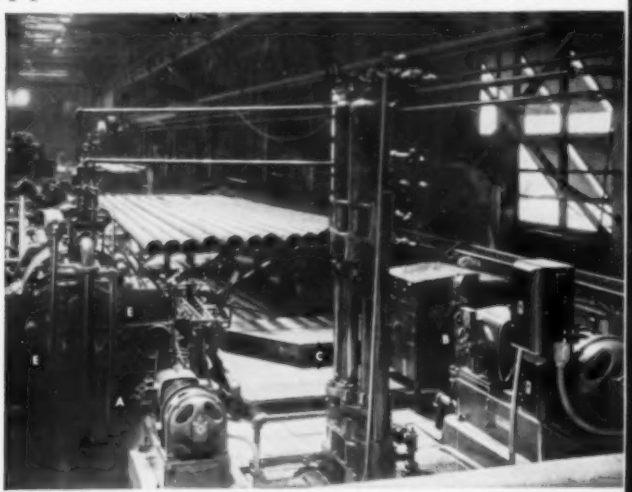
...Fluid Power news

OILGEAR 40 Years of Fluid Power

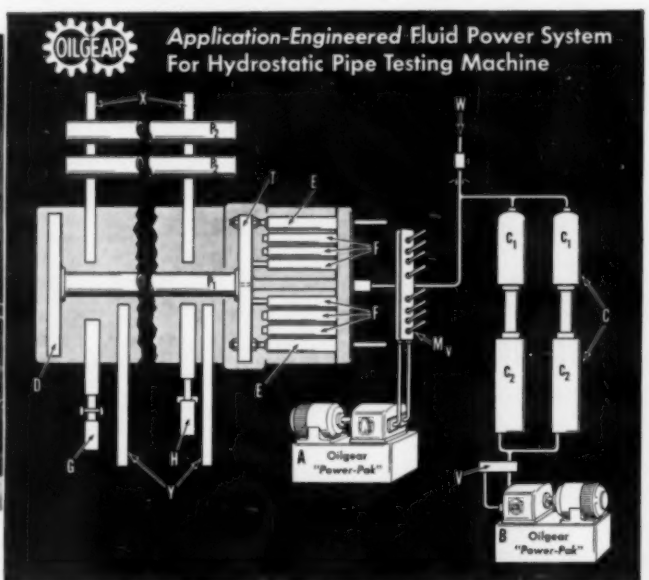
From Oilgear *Application-Engineering* Files

HOW OILGEAR SYSTEM POWERS PIPE TESTER EFFICIENTLY AFTER 23 TROUBLE-FREE YEARS

DATA: To supply power and control system for five functions of a hydrostatic pipe testing machine designed for a wide variety of pipe sizes and testing pressures ranging up to 6000 psi. Linear drives and controls were needed to: *1.* Actuate jaw-type clamps to hold and prevent pipe from buckling. *2.* Traverse testing head rapidly to and from testing position. *3.* Hold testing head against pipe under testing pressures. *4.* Actuate "knockout" arms to eject tested pipe from machine. *5.* Actuate an intensifier to boost water used for testing from city pressure to any selected testing pressure up to 6000 psi. *Specific Operating Requirements:* Simple, safe, dependable; capable of continuous, 'round-the-clock operation, 6 days per week in highly humid atmosphere; cycle rapidly for economical production; require a minimum of maintenance to prevent costly, line-stopping downtime; must be compact to conserve valuable floor space, economical in the use of electrical power.



Hydrostatic Pipe Tester with Oilgear *Application-Engineered Fluid Power System* as installed in 1937, and operating continuously since that time. Oilgear "Power-Paks" (A,B), Intensifier (C), Rapid Traverse Testing Head Cylinders (E) are indicated by arrows. Manifold and Control Valves at operator's station (M_V in drawing) are clearly visible, as are the direct-reading, operating pressure gages on the "Power-Paks." Testing pressures are quickly preset with a small handwheel on "Power-Pak" (B)—not visible. Pipe to be tested rolls directly from pre-testing storage racks, at right, directly into the machine.



HOW IT WORKS: Pipe to be tested (P_2) rolls from storage rack (X) into cradle of machine between Testing Head (T) and Tail Carriage (D). Testing Head (T) is moved forward quickly by Double-Acting Cylinders (E). Clamping Jaws actuated by Cylinder (G) grip the pipe along its length to prevent buckling. Pipe (P_1) is pre-filled with water at city pressure (W). Single-Acting Test Head Holding Cylinders (F) move up in matching pairs—2, 4, 6, 8, 10, or all 12 can be selected—depending on pipe size and testing pressure to hold Testing Head (T) against Pipe (P_1) and Tail Carriage (D). Movement of cylinders (E, F, G, H) are all controlled by valves mounted on Manifold (M_V) which direct fluid flow from Oilgear "Power-Pak" (A). Water at preselected test pressure from Intensifier (C) then exerts pressure on Pipe (P_1). Oilgear "Power-Pak" (B) supplies *Fluid Power* through Valve (V) to actuate Hydraulic Intensifier Cylinders (C_2) increasing pressure in Water Cylinders (C_1) to any desired pressure up to 6000 psi. After pipe is inspected, intensifier pressure is released, Testing Head (T) is rapidly retracted, and Knockout Cylinder (H) actuates mechanism to eject tested pipe onto rack (Y). Machine is then ready to start a new test cycle.

SOLUTION: An *Oilgear Application-Engineered System* consisting of two Oilgear Heavy-Duty "*Power-Paks*," Directional Control Valves, and "Custom-Quality" Cylinders. Each "*Power-Pak*" uses an Oilgear Heavy-Duty One-Way Variable Displacement Radial Rolling Piston Pump with automatic pressure unloading control to reduce pump stroke when holding a preset pressure indefinitely; eliminate excessive heating and power loss; reduce electrical power input requirements. Oilgear Pumps contain integral auxiliary systems for pilot, supercharge, cooling and filtering . . . with constant pressure and flood self-lubrication, conservatively loaded anti-friction bearings, and large internal passages—mechanical and hydraulic friction is reduced to a minimum for high efficiency . . . virtually guaranteeing a long, trouble-free, maintenance-free life.

USER REPORTED IN 1938—"*. . . after one year of operation we have nothing but the highest praise for the Oilgear Equipment on this pipe tester.*"

USER REPORTS IN 1960—"*This machine has given us years of trouble-free service, operating around the clock six days a week . . . maintenance has been at a minimum, with occasional changes in intensifier packings, as would be expected in normal operation . . . performance has been completely satisfactory.*"

With Oilgear Heavy-Duty System Components designed for thousands of hours of continuous service at full rated load, savings are compounded with every hour of uninterrupted performance. That's why machinery and equipment manufacturers and *their* customers say . . .
"*For the lowest cost per year . . . it's Oilgear!*"

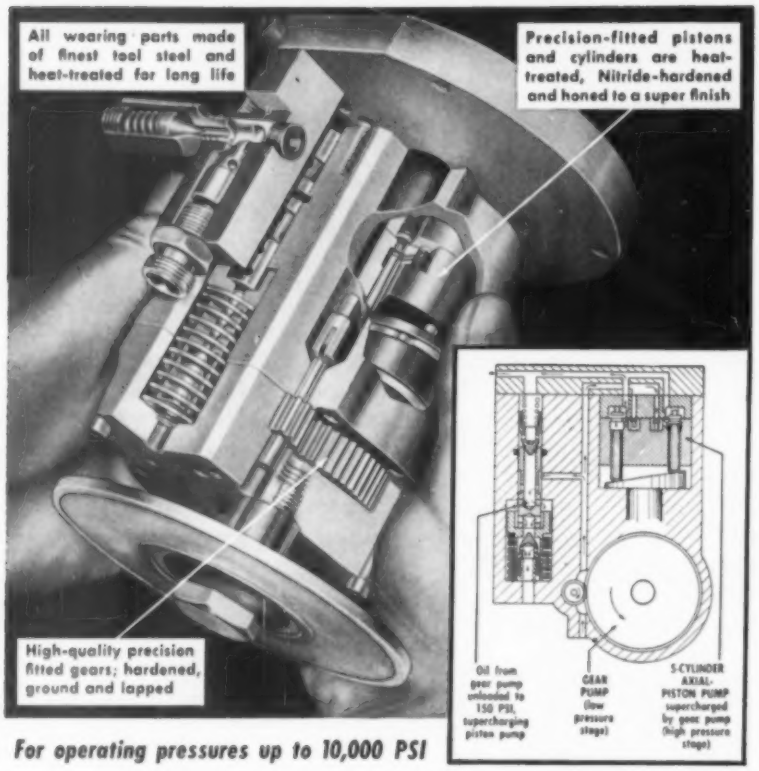
For solutions *to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .*

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1564 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code 414


All wearing parts made of finest tool steel and heat-treated for long life
Precision-fitted pistons and cylinders are heat-treated, Nitride-hardened and honed to a super finish
High-quality precision fitted gears; hardened, ground and lapped
Oil from gear pump unloaded to 150 PSI, supercharging piston pump
GEAR PUMP (low pressure stage)
5-CYLINDER AXIAL-PISTON PUMP supercharged by gear pump (high pressure stage)

For operating pressures up to 10,000 PSI

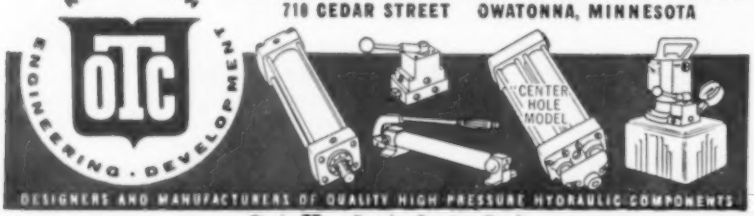
New, unique 2-stage hi-pressure hydraulic pumping unit—dual-volume, dual-pressure

- **DELIVERS HIGH-VOLUME AT LOW PRESSURE**
- **2.6 GPM @ 100 PSI**
  1.75 GPM @ 500 PSI
  80 CU. IN./MIN. @ 1,000 PSI
  50 CU. IN./MIN. @ 10,000 PSI

The new and modern OTC "Vanguard" hi-lo hydraulic power package is a precision-built, high-quality unit meticulously crafted for dependable performance and long life. To best utilize the "Vanguard's" exceptional performance, a wide range of accessories are available: your choice of several motors, gasoline engine, 2 and 4-way lever-control valves, 2-way solenoid valve, pressure regulating valve, manifold, reservoirs, gauges, etc.

For detailed information on this advanced, new unit, write:

PRECISION HYDRAULICS DIVISION
OWATONNA TOOL CO.
710 CEDAR STREET OWATONNA, MINNESOTA



Circle **77** on Reader-Service Card

LETTERS to the editor

Address your letters to: The Editor, HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Needs 20-gpm servovalve

TO THE EDITOR:

I would be interested to know if there is available a servo controlled, pressure compensated, flow control valve in a size to handle 20 gpm. Perhaps you would be aware of a manufacturer who makes a valve of this type for industrial use.

R. T. MERCER
Project Engineer
Lennox Tool & Machine
Lima, Ohio

We've sent you the names of several manufacturers who have specialized in servovalves for industrial applications. The February 1959 *issue of* HYDRAULICS & PNEUMATICS *had a 12-page report on What You Can Get in Electrohydraulic Servovalves. It should be helpful in selecting a valve to meet your specifications.*

Air solubility

TO THE EDITOR:

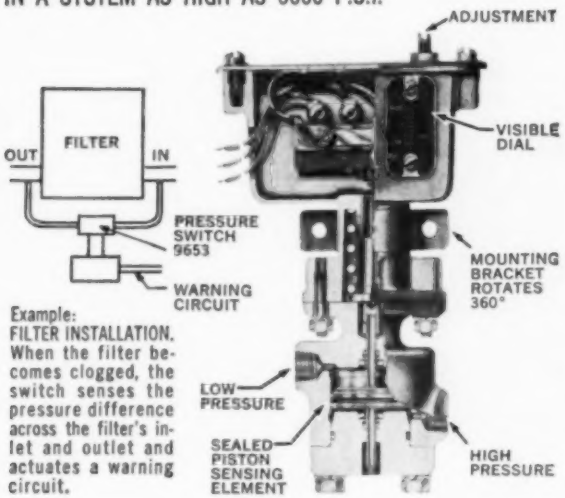
The article *Measuring Air Solubility in Hydraulics Fluids* which appeared in the August 1960 issue was most interesting, because it was the first time that I have seen a comparison of solubility of air in petroleum base and water base fluids. Although there are statements as to percentages after holding pressure on the fluid for four months at 200 psi, there is no indication whether the volume shown in the curves is milliliters per barrel or milliliters per liter. To make use of the curves, it appears to me that we must know what volume of fluid is involved.

It would be interesting to have another article in the future with more complete data, such as how much air is soluble in both types of fluids under various pressures.

Continued on page 14

NEW PRESSURE DIFFERENCE SWITCH

SENSES A LOW DIFFERENCE OF 10 P.S.I. EVEN IN A SYSTEM AS HIGH AS 5000 P.S.I.



Example:
FILTER INSTALLATION. When the filter becomes clogged, the switch senses the pressure difference across the filter's inlet and outlet and actuates a warning circuit.

The new Model 9653 is constructed to sense a difference from 5 P.S.I. to 140 P.S.I. between two pressures. A sealed piston sensing element actuates an electric circuit on increasing or decreasing of a predetermined pressure difference. It is applicable to oil systems ranging from 50 P.S.I. to 6000 P.S.I. working pressure. A high proof pressure rating of 9000 P.S.I. is your protection against damage from surges and shock loads. Field setting is simplified by means of an external adjustment screw and visible dial.

WE BUILD IN	WE DON'T USE
RUGGEDNESS Can take surges— (High proof pressures) Continuous operation— (Millions of cycles) No sticking— (in dirty fluid)	**LINKAGES & BEARINGS** Which wear quickly—(cause settings to drift and switch to fail).
LABOR & MATERIAL SAVINGS No return drain piping— (Sealed piston) Mounts where convenient (Operates in any position, Not sensitive to vibration)	**UNSEALED PISTONS** Which add to your installation cost (return piping). Are critical to dirt— (pistons get stuck).

Ask for new pressure switch handbook and catalog '59-'60

PRESSURE SWITCH DIVISION

Barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

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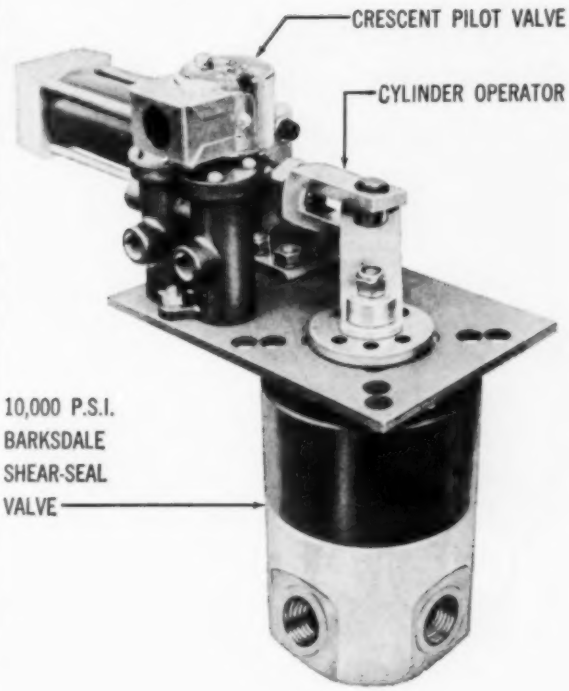
CYLINDER OPERATED "SHEAR-SEAL" VALVES



Remote control operators for 10000 P.S.I., 6000 P.S.I. and 3000 P.S.I. "Shear-Seal" Valves are available with cushioned or non-cushioned cylinders.

4-Way, 3-Way and Shut-off valves range in pipe sizes from ¼" to 1 ½" N.P.T.

For complete data request catalog COV-60-61.

CONTROL VALVE DIVISION

Barksdale valves

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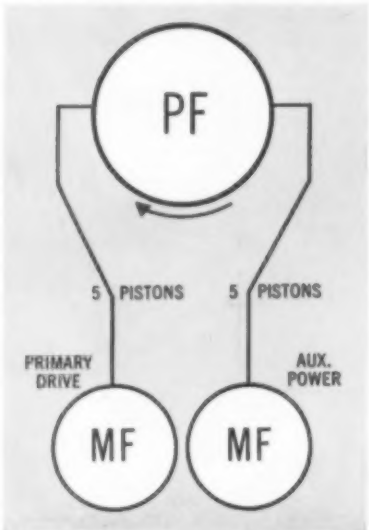
Dynex offers

FLEXIBILITY UNLIMITED

with the

Split-Flow, High-Pressure

Hydrostatic Transmission



Remember the hydrostatic transmission? It utilizes fluid *pressure* instead of fluid velocity to yield output energy. Dynex *high-pressure* makes it practical—in performance . . . in efficiency . . . in price. Offers constant torque with synchronous speed.

Dynex "Split-Flow" gives this efficient transmission infinite versatility. One pump does the work of several. Operates multiple circuits simultaneously. For primary drives, auxiliary power . . . name it!

You'll find exciting potential in this unique Dynex development. Write for facts and engineering data.

Circle 29 on Reader-Service Card

LETTERS

The present article apparently applies only to the amount of air left after the pressure is released. When a volume of oil is compressed with air present in the chamber many times the volume of oil is soluble. Whenever the pressure is released, this air separates out in bubbles.

An article on this would be interesting from the standpoint of bleeding air out of cylinders on hydraulic systems, whether bleeders are necessary, and what fluid would be best in minimizing problems with air.

REX C. BURNHAM
J. N. Fauver Co., Inc.
Detroit, Mich.

Volumes shown in the curves are in milliliters per liter.

Quoting from the original text of the article the procedure was as follows: "Starting with the free floating piston in the extended position, 1000 mls of the test fluid were drawn into the distal, or air, side of the accumulator using the pump as a means of suction. Suction was continued until the piston bottomed. Since displacement of the accumulator was 3200 mls, this meant 2200 mls of air plus 1000 mls of fluid were contained within. The valve at the top of the accumulator was then closed and the pump converted to pressure. The system pressure was controlled by the predetermined set of the relief valve. When the desired pressure was reached, the valves were closed tightly leaving the ballast accumulator to maintain constant and steady pressure." The authors have indicated in their paper that a subsequent program would be conducted at elevated temperatures.

Interested in rotary actuator

TO THE EDITOR:

In your February '60 issue you had an article on a compact rotary actuator. Our company is extremely interested in receiving more information on these actuators. According to your article they were developed in Gothenberg, Sweden for actuating ship hatch covers. Is there a representative in this country, or should we write directly to Sweden for further information? We are presently redesigning a rotary type actuation motion and need further information.

OTTO A. NEUMANN
Group Engineer
Ingersoll Kalamazoo Div.
Borg-Warner Corp.
Kalamazoo, Mich.

The address of Gotaverken has been sent. We've been amazed at the interest this article continues to create.

Adjustable stroke cylinders

TO THE EDITOR:

We would appreciate knowing who manufactures a hydraulic cylinder of 1½" bore by approximately 8" stroke. The cylinder should also have an adjustable stroke control feature.

WILLIAM R. ROESCHEN
Chief Engineer
Highway Equipment Co.
Cedar Rapids, Iowa

We've sent names of three manufacturers who indicated in the January Designers Guide issue of HYDRAULICS & PNEUMATICS *that they make standard cylinders meeting these specifications. There are also a number of companies who indicate they make special cylinders in this size.*

Starting hydraulic course

TO THE EDITOR:

We are trying to secure information to assist us in setting up a hydraulic course with labs in some of our training programs. Your name was given to us as possibly having published at one time a booklet called *A Beginner's Course in Basic Pneumatics.* We would like to obtain a copy.

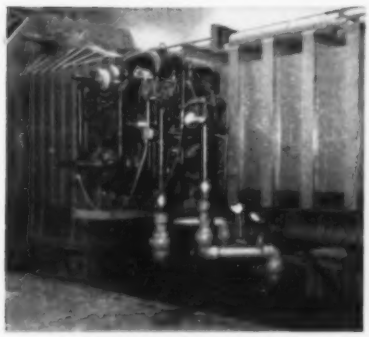
H. G. KNIGHTEN
Director
Florida Parishes Vocational School
Greensburg, Louisiana

A Beginner's Course in Basic Pneumatic is out of print and no longer available. We have sent information about the FLUID POWER DIRECTORY *and also a bibliography of books which are available on hydraulics and pneumatics.* ▼▼▼

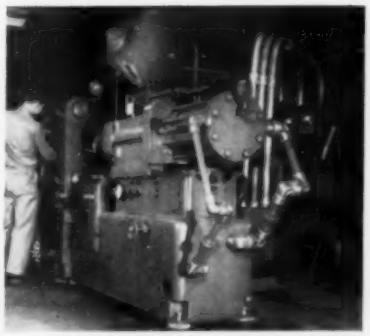
ON EQUIPMENT LINES ■

CHIKSAN SWIVEL JOINTS

team up strength + flexibility + endurance...



QUICK DISCONNECT FOR A SUPERSONIC WIND TUNNEL—On lines that require frequent disconnecting, such as on this wind tunnel, Chiksan swivel jointed assemblies, teamed with Weco Unions, disconnect quickly, swing out of the way and then back into perfect alignment. **For application details, request report 008.**

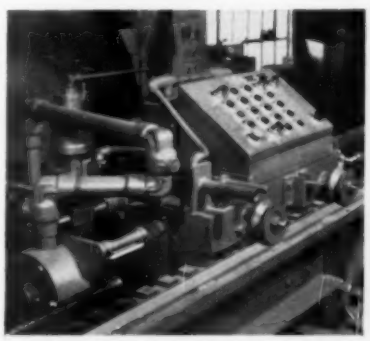


0 TO 2000 PSI IN ONE SECOND—injection molding machine lines must be flexible. Safety is a must. Endurance highly desirable. Chiksan Swivel Joints not only fulfilled these important requirements but their savings in replacement cost soon paid for the swivel joints. **For applicable details request report 001.**

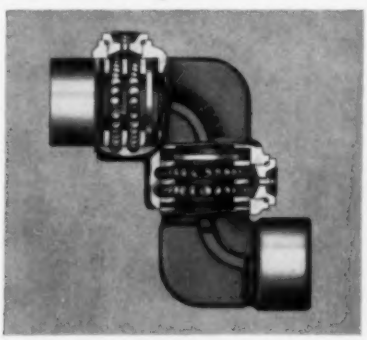
SAFETY LINK FOR JET-FUEL DELIVERIES—In design of trailer tankers for fueling jet aircraft one danger point was the suction line from pump to the trailer. By employing Chiksan Swivel Joints desired flexibility was maintained and the danger of kinking was eliminated. **For application details request report 006.**

When moving machine parts cause tight bend or twist on hose lines, Chiksan Swivel Joints are a ready solution. Or when your design dictates the use of flexible metal lines, Chiksan Swivel Joints allow controlled flexibility. Whenever line endurance, strength and flexibility are desired Chiksan Swivel Joints may offer a ready solution.

Chiksan Swivel Joints with their infinite service life, full 360° rotation and high safety factor, quickly pay for themselves by minimizing hose replacement and by eliminating costly line failure, fluid loss and downtime. For expert advice on your line design problems contact Chiksan. A nearby representative will call, analyze your requirements, and make specific recommendations.



ON THE MOVE 24 HOURS A DAY—Every five seconds right around the clock this machine tests finished pipe with water under pressures up to 1000 psi. Line movement is almost continuous. The solution. For safe, flexible lines of maximum endurance—Chiksan Swivel Joints. **For application details request report 010.**



DESIGN WITH SWIVEL JOINTS—Over 2,000 different types, sizes and styles give you an excellent selection of swivel joints for your design application.

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Please send me product application report ☐ .001 ☐ .006 ☐ .008 ☐ .010

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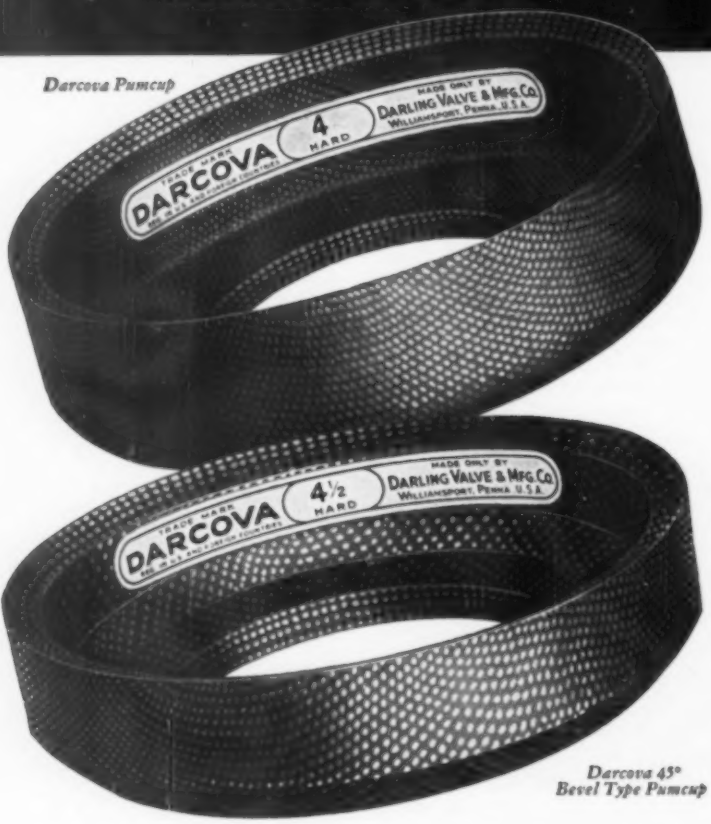
now available with

100% NYLON COMPOSITION

for HYDRAULIC CONTROLS, AIR CYLINDERS, RECIPROCATING PUMPS



Darcova Pumcup

Darcova 45° Bevel Type Pumcup

DARLING Pumcups—long noted for unequalled efficiency and life in all kinds of cylinders—are now greatly exceeding their own performance records! The new 100% Nylon Composition, available *only* in Darcova Pumcups, does it!

Nylon Pumcups are made in sizes, types and textures exactly right for your particular equipment—ready *now* to give you unprecedented piston packing performance!

Write for helpful data Bulletin No. 5903.

DARLING VALVE & MANUFACTURING CO.

Williamsport 15, Pa.

DARCOVA

TRADE MARK

PUMCUPS

Circle **25** on Reader-Service Card

FLUID POWER FORUM

Each month HYDRAULICS & PNEUMATICS surveys readers for their experiences and opinions in fluid power design.

When you needed a special purpose valve (hydraulic, pneumatic, water, servo, cryogenic, hot gas, etc.) were you able to buy it? Did you have to modify a standard valve, or did the manufacturer do it for you? What modifications were made?

In general the applications we make are from manufacturer's standard design. On occasion we have required the alteration of a standard or existing design to suit a particular military or conventional application. When this situation arises, we have the valve manufacturer make the modification for us. In most instances the valves were made locally, and the changes presented no problem. Changes included such items as body configuration, spool fit and design, and environmental capability.

R. ANGSTADT
Design Engineer
United States Steel Corp.
Los Angeles, Calif.

We had an application for a pilot-operated valve to dump oil at 3000-psi with 80-psi pilot pressure. This problem was solved by using a 2-way, solenoid-operated valve, with the solenoid removed, in combination with a spring return cylinder with 1⅛-in bore and 1-in. stroke. This combination worked fine and the cost was low.

JOE HENDERSON
President
Henderson Engineering Co.
Chicago, Ill.

A special application required two, eight-inch remote control valves for handling the hot exhaust

Continued on page 19

another **NEW PRODUCT** *from* Modernair®

SERIES **S**

Veri-Trol® HYDRAULIC CHECKING CYLINDERS

Series S VERI-TROL Hydraulic Checking cylinders offer the simplest, most economical means to provide hydraulic control of air cylinder stroke speed.

Features include:

- 1,000 lb. max. checking capacity on out stroke, free return.
- Dial-set speed control, 1" to 300" per minute.
- Visual "low oil" signal; easy refilling.
- Works with any suitable air cylinder.
- Built-in rod wipers with automatic compensation for wear.
- Chrome-plated steel piston rods with wrench flats.
- Available in standard checking stroke lengths through 18", longer stroke lengths on order.
- INTERCHANGEABLE MOUNTING BRACKETS. (Standard with all Modernair 1½" bore cylinders)

VERI-TROL Hydraulic Checking Cylinders are available either in the new low-cost Series S, described above, or in the precision-control Series HC which offers load-compensated speed control, single or double-acting, built-in skip, stop or skip-stop controls. Series HC checking cylinders provide 2,000 lb. checking capacity. For complete information, call your nearest Modernair dealer (see listing in your phone book yellow pages), or write:

Modernair® CORPORATION

400 Preda Street • SAN LEANDRO, CALIFORNIA • Phone: LOckhaven 2-6485

5007 Brookpark Road • CLEVELAND 34, OHIO • Phone: SHadyside 9-6393

MEMBER NATIONAL FLUID POWER ASSOCIATION

Patent Pending

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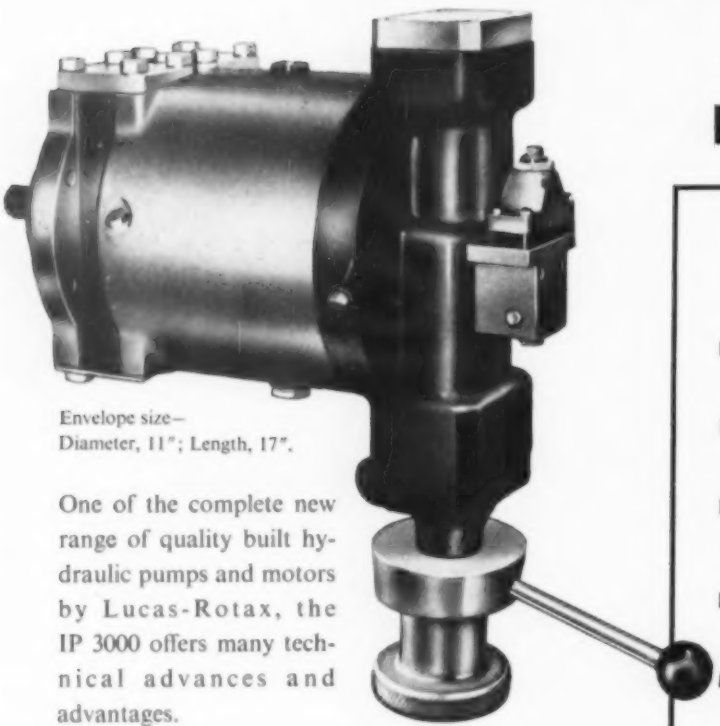
Unmatched in performance, quiet... the reliable

NEW IP 3000 INDUSTRIAL HYDRAULIC PUMP

by

LUCAS-ROTAX



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Diameter, 11"; Length, 17".

One of the complete new range of quality built hydraulic pumps and motors by Lucas-Rotax, the IP 3000 offers many technical advances and advantages.

- **Smaller size**
- **Lower weight**
- **Variable volume**
- **Low noise level at higher operating speeds**
- **Low cost**
- **High efficiency**
- **Fitted with pressure compensator as standard equipment**

For further information, contact the agent or office nearest you today, or write for technical literature.

PUMP DETAIL

	Basic Pump Fixed Stroke
Fluid displacement (cub. ins./rev.)	13.89
Nominal working pressure (peak)	5000
(lb. per sq. in) (continuous)	3000
Nominal speed (peak)	2000
(r.p.m.) (continuous)	1800
Input h.p. at 1,000 r.p.m. and 1,000 lb. per sq. in. differential	38
Max. Torque (lb./ft.) per 1,000 lb. per sq. in. fluid pressure differential	200
Recommended Inlet Pressure (p.s.i.g.)	60
Weight (lb.) Basic Pump	128
Operating temperature	—40 to 200°F

a product of creative engineering by

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6010

FORUM

gases from a gas generator operating at 1650 F to 1750 F. The valves would be exposed to the hot exhaust gas for three minutes. A valve manufacturer made a few changes in the trim and relaxed the tolerance on the mating parts on their heavy duty, cylinder-operated valve, so it could be used with high temperature gas.

We are handling cryogenic propellants and the new storable propellants which present new problems. Our section builds all test fixtures for testing missile components, as well as fixtures for the development of new missile design concepts.

J. WOYTASSEK
Engineer
Cold Flow Design Section
The Martin Company
Denver, Colorado

• ***Are you using fire-resistant hydraulic fluid? What type do you prefer? What difficulties have you had with it, and what improvements would you like to see?***

While I do not use fire-resistant hydraulic fluid at present, there is another improvement I would like to see. A piston seal that allows no leakage of air at 75 psi to a hydraulic fluid on the other side and keeps the hydraulic fluid from leaking to the air side.

J. M. MATUSZAK
Chief Engineer
Sel Set. Machinery Co.
Salem, Oregon

Yes, we use fire-resistant hydraulic fluids for hot platen presses. Difficulties arose from pump cavitation and with conversion of packings and O-rings to butyl compounds. Strainers of 100 mesh and finer caused the pump cavitation because they were too fine for the heavier fire-resistant fluid. Changing to 60-mesh strainer partially corrected our trouble. Of course, maintenance increased because of pump failures for the above reason.

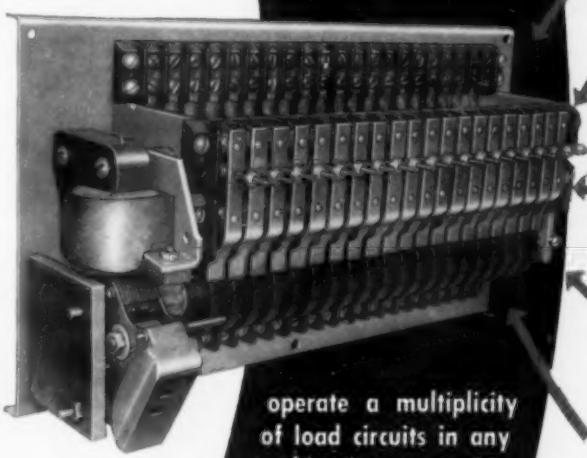
We would like to see a fire-

Continued on page 21

A NEW APPROACH TO MACHINE PROCESS CONTROL
Step Sequencing

the new Eagle Step Switch

use any type of time or sensing device to advance the Eagle Step Switch



PUSH BUTTON
LIMIT SWITCH
INTERVAL TIMER
PRESSURE CHANGE
LEVEL CONTROL

operate a multiplicity of load circuits in any combination up to 19 circuits

This new Eagle Step Switch also provides:

1 SEQUENCING INTERLOCK when used with multiple indexing circuits.

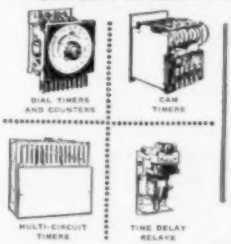
2 10 AMP SWITCH CONTACTS control load switches direct — no need for load relays.

3 MECHANICAL CIRCUIT INTERLOCK by cam action — eliminates interlocking relays.

4 115 VOLT COIL operates direct on AC with heavy duty ratchet mechanism — insures long life.

Write us regarding your count problem, or see your local phone directory or Thomas Register under the heading, "Timers, Electric" or Conover Mast Purchasing Directory, for your nearest Eagle Signal representative.

OTHER POPULAR HIGH QUALITY EAGLE TIME-COUNT CONTROLS



BLISS EAGLE SIGNAL COMPANY • Moline, Illinois
A DIVISION OF THE GAMEWELL COMPANY, AN E. W. BLISS COMPANY SUBSIDIARY

MANUFACTURERS OF A COMPLETE LINE OF INDUSTRIAL TIME-COUNT CONTROLS

Circle 30 on Reader-Service Card

REMEMBER COLLAR BUTTONS?

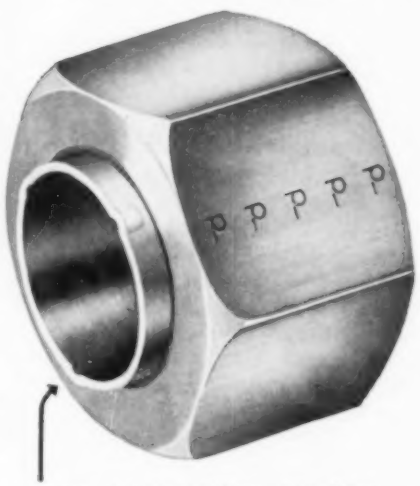
NOW **PARKER** HAS ELIMINATED A MORE SERIOUS ANNOYANCE ...LOST TUBE FITTING FERRULES!

A simple change in the design of Parker "Intru-lok®," the positive, bite-type Parker fitting for copper, aluminum or plastic tubing, has solved an age-old problem.

Small three- and four-piece tube fittings have long been a pain in the neck on applications where it is necessary to remove the nut from the fitting. The ferrule(s) fall out and promptly disappear. If and when found, they often get put in backwards. Sometimes they never get put back at all. Result, in either case: a leaking joint.

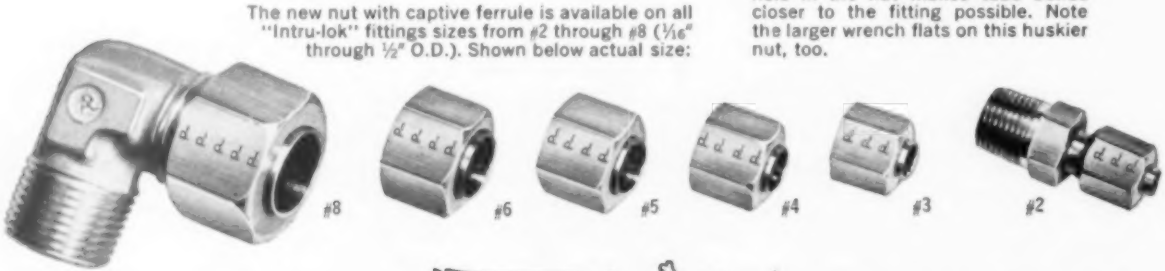
Now Parker has developed a snap-in, captive ferrule for "Intru-lok." You can take it out of the nut, "on purpose," but you can't drop it out accidentally.

You get all the leakproof safety of a three-piece fitting with positive "bite." You also get the convenience, the quick, easy assembly of a two-piece fitting. The easiest fitting to install has been made even easier. Write for new "Intru-lok" dimensions and prices today.



Three "detents" hold the "tail" of the new ferrule in the nut. Also, the larger hole in the nut makes tube bends closer to the fitting possible. Note the larger wrench flats on this huskier nut, too.

The new nut with captive ferrule is available on all "Intru-lok" fittings sizes from #2 through #8 (1/16" through 1/2" O.D.). Shown below actual size:



Parker FITTINGS AND HOSE DIVISION
17325 Euclid Avenue • Cleveland 12, Ohio
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS
3878-PH
EUROPEAN DIVISION • PARKER-HANNIFIN N.V. • SCHIPHOL • THE NETHERLANDS

FORUM

We would like to see a fire-resistant hydraulic fluid that is not water soluble and that has the same qualities as standard oil. Then machines can be used without the costly conversion of all packings and O-rings to butyl. Water soluble fluids are not satisfactory because we use vacuum in some applications to evacuate the dies and fluid cells of oil.

I have a question: Is it possible to manufacture a fire-resistant fluid with a flash point of 1200 F and higher to be used in forming titanium.

WILLIAM VERGE
Equipment Engineer
Grumman Aircraft Engineering Corp.
Bethpage, L. I., N. Y.

● ***Cylinder manufacturers are working toward standardized cylinder mountings. Would standardization be helpful to you?***

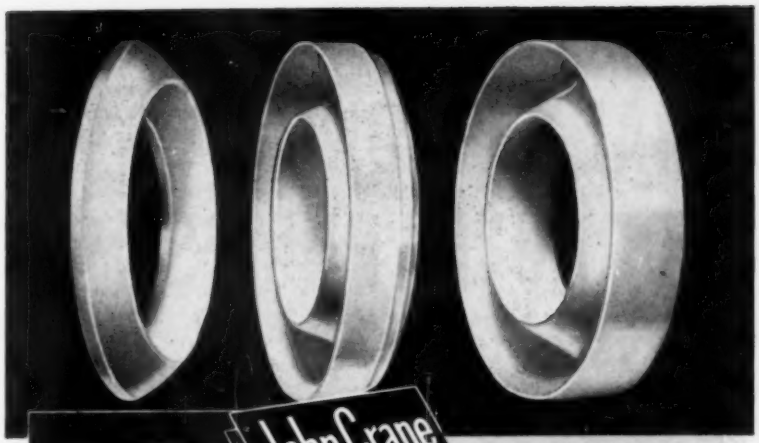
Standardization of cylinder mountings would be very helpful to engineers when designing and manufacturing machinery. It would also help in the replacement of cylinders if it was necessary to change from one make of cylinder to another. It would also eliminate competition because every cylinder salesman would have a cylinder to fit his competitors' mountings.

A. H. FRENCH
A. H. French & Sons
Alpens, Michigan

DESIGNERS GUIDE
to fluid power products

Copies are available:
single copy $1.00
25-49 copies $ .75 ea.
50 or more $ .50 ea.

Write to
HYDRAULICS & PNEUMATICS
812 Huron Rd.
Cleveland 15, Ohio



John Crane

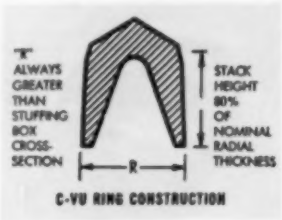
CHEMLON *

C-V RINGS
ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

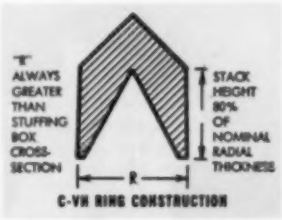
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



C-VH RING CONSTRUCTION

TWO STYLES ARE AVAILABLE:

C-VU RINGS ***for low pressure service*** —such as control and regulator valves handling gases and fluids, where it is necessary to have a very sensitive and resilient type packing.

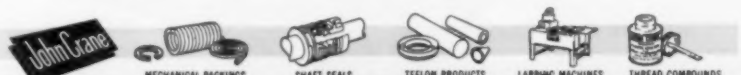
C-VH RINGS ***for high pressure service*** —for use in pumps, hydraulic cylinders and like services at pressures ranging to 500 psi. and over. These rings are constructed with a heavy wall heel to withstand pressure requirements. They are designed to provide voids between rings, so that as the Teflon expands due to heat, this take-up room minimizes any excess friction in the stuffing box.

"John Crane" C-V Rings are available in full line of standard sizes and male and female adaptors. Sizes can be molded to stuffing box specifications.

Request Bulletin P-325.

*"John Crane" C-V Rings are made from Chemlon—*the best in DuPont Teflon.*

Crane Packing Co., 6405 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*



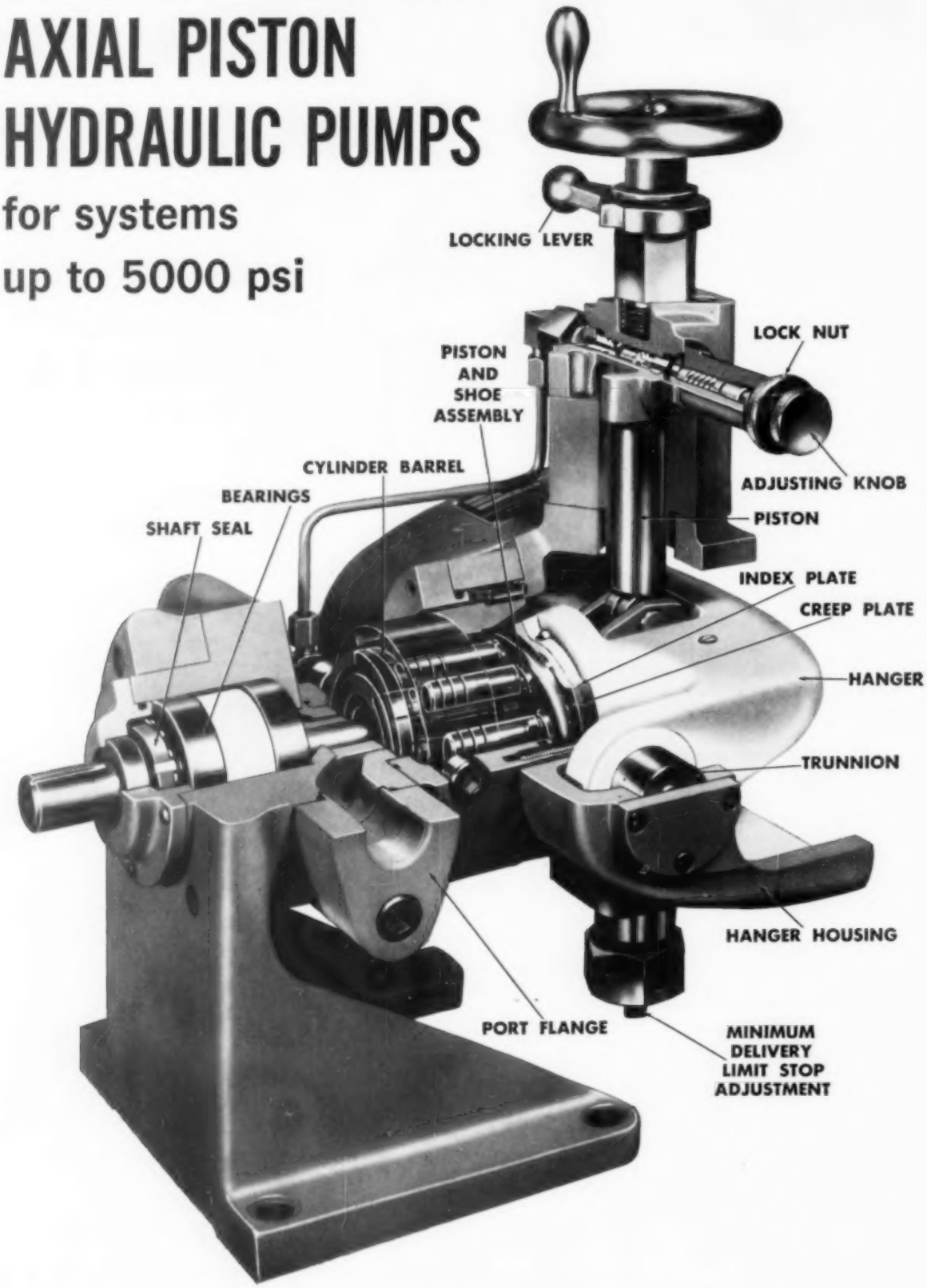
CRANE PACKING COMPANY

Circle **23** on Reader-Service Card

Design of variable volume

AXIAL PISTON HYDRAULIC PUMPS

for systems up to 5000 psi



By: Ellis H. Born

Director of Sales-Engineering
Denison Engineering Division
American Brake Shoe Co.
Columbus, Ohio

With today's ever-increasing requirements in the transmission of higher horsepower, the designer must look to hydraulic components that will give the greatest transmission efficiency with the lowest possible cost and the smallest possible package. With smaller, lighter, more powerful equipment—operating pressures of 2000, 3000 and 5000 psi are becoming commonplace. To meet the needs of higher pressures with a high degree of reliability, axial piston pumps and motors of proper design should be considered.

For 5000 psi requirements, the axial piston pump (illustrated) is a logical choice. It operates on the principle of a series of pistons in a common barrel that progressively draw oil into the barrel on the suction stroke and force oil from the barrel into the line on the discharge stroke.

With this simple axial piston design, direct and unrestricted flow into the pumping assembly is possible, eliminating the need for the large flow areas used and the moving seals which, in turn, eliminates maintenance. Direct flow path further insures good suction characteristics —a highly desirable operating advantage for obtaining efficient hydraulic performance.

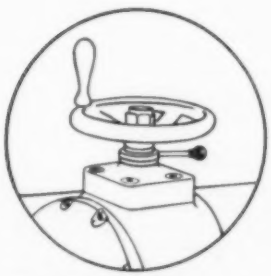
The port plate of the Denison pump is designed as an axial hydrostatic bearing which balances out the thrust of the cylinder barrel, leaving only sufficient force to create a positive seal contact between the cylinder port plate and the cylinder barrel. Because of reduced thrust, wear on mating surfaces is decreased and pump life is greatly extended at all pressures up to 5000 psi.

Where variable volume is required, it is logically desirable (for efficiency, simplicity and low maintenance) to eliminate the need for varying the position or angle of the cylinder barrel to regulate volume. In the Denison axial piston pump, output up to 125 gpm is simply regulated by varying cam plate angle. Zero to full flow or flow reversal is regulated by handwheel, hydraulic cylinder, stem, electric motor, compensator or electrohydraulically.

In the Denison design, the line of action of the combined radial load of all pistons is through the roller bearing supporting the cylinder barrel. The use of a large bearing provides non-deflecting support for these radial forces. As a result, unbalanced or twisting offset that would tend to unseat the cylinder barrel from the port plate is eliminated. A continuous, effective sealing action of the barrel against the port plate is maintained to promote high pumping efficiency.

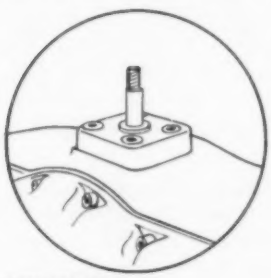
Piston and shoe assembly design also reduces by one-half the number of ball and socket couplings found in other types of axial piston pump construction. The shoes hydraulically balance out all piston thrust, eliminating need for thrust bearings.

Data and specifications on 5000 psi pumps, motors and controls are available from your Denison representative—located in principal cities—to assist you in developing hydraulic systems for maximum efficiency and economy.

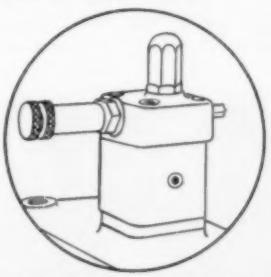


HANDWHEEL CONTROL
...with locking device for accurate manual pump volume regulation.

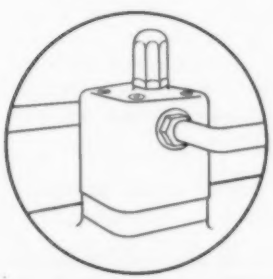
ELECTRIC MOTOR CONTROL
...adjusts pump volume to desired level. Integral brake in gear-head motor eliminates over-travel.



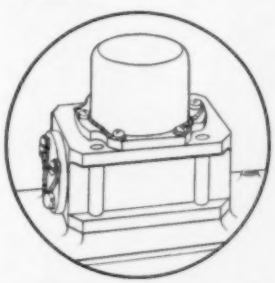
STEM CONTROL
...provides mechanical linkage to the driven equipment.



PRESSURE COMPENSATOR CONTROL
...affords automatic regulation of pump volume to meet preset pressure demands.



HYDRAULIC CYLINDER CONTROL
...similar to stem control, except volume is hydraulically regulated.



ELECTRO-HYDRAULIC CONTROL
...utilizes sensitive, system error-detecting unit which energizes hydraulic volume control piston.

NEW CATALOG FOR DESIGNERS AND ENGINEERS

Write for your copy of Bulletin 220—"Hydraulic power to 5000 psi". Includes complete specifications, operating data and applications for Denison's full line of hydraulic pumps, motors and controls.

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1166 Dublin Road • Columbus 16, Ohio

Circle **26** on Reader-Service Card

BRIEFS

about fluid power

Fluid Power Servesthe Marine Industry

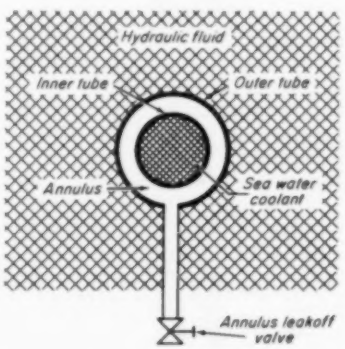
NEW YORK—Hydraulic design needs and considerations vary greatly from submarines to dredges and dock equipment. These requirements and the equipment to meet them were discussed at the Second Annual Naval and Marine Conference sponsored by Vickers, Inc., last November.

The two-day meeting was attended by 200 ship builders, designers, naval architects, operators, and manufacturers. The sessions were moderated by Captain William D. Rosenborough, Jr., USN, Head of the Submarine Branch, and Mr. Preston H. Hadley, Jr., Special Assistant for Gibbs & Cox, Inc., New York. The conference opened with a comprehensive discussion on submarine hydraulics reliability.

• **Submarine Hydraulic Design**—Ways of achieving reliability in submarine hydraulic design were reviewed by Walter H. Tisdale, senior design engineer, Electric Boat Div., General Dynamics. He gave examples of designs used to help insure hydraulic system reliability.

Sea water is the most abundant available media for submarine heat exchangers, yet its corrosive action can readily ruin a submarine's hydraulic system. To prevent this, a double tube heat exchanger, equipped with a leakage warning device, is used. The tube bundle consists of a tube within a tube, with a small annulus between them. The annulus is drained off to a single leak-off tube, which warns of any leakage in the annulus, whether from hydraulic fluid, or sea water.

Sea water can also penetrate a submarine's hydraulic system through actuators located outside the pressure hull. To prevent overall system contamination, externally mounted actuators have a hydraulic system that is separate from the ship's internal hydraulic system. Each actuator rod is also fitted with a double seal and leak-off line.

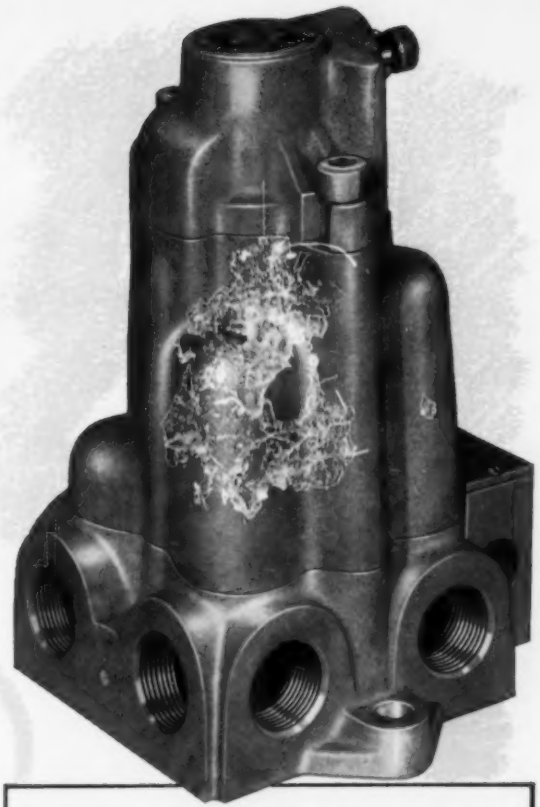


DOUBLE TUBE COOLER drains off leakage to prevent contamination of hydraulic system by salt water.

Continued on page 26

MODERATORS FOR THE HYDRAULIC CONFERENCE were Captain W. D. Roseborough, Jr., USN, Bureau of Ships, and Mr. P. H. Hadley, Jr., special assistant, Gibbs & Cox.

It's new! HUNT ONE INCH PDQ VALVE



TOPS in accessibility
TOPS in simplicity
TOPS in speed
TOPS in capacity
TOPS in quality

Cylinder ports front, side and bottom-tapped; supply and exhaust ports side and bottom-tapped; basic 1 in. PDQ available tapped ¾, 1 or 1¼ in. NPT (also basic ½ in. PDQ tapped ⅜, ½ or ¾ in. NPT); for air or vacuum service, pressures from 0 to 125 psig; meets JIC Standards.

Now you can have all the performance-proved advantages of Hunt's PDQ center-line design PLUS the high capacity of full 1" size. The PDQ's short stroke pilot and compact, lightweight, single spindle poppet provide lightning-fast response and near-instantaneous full flow. All this in a compact package weighing only 10.8 pounds!

Look at these performance figures. The 1" PDQ, with 100 psig supply, fills a 400 cu. in. vessel to 90 psig in but 0.288 seconds (17.3 electrical cycles) . . . exhausts the same vessel from 100 to 10 psig in 0.200 seconds (12 electrical cycles) and, at 100 psig, its flow capacity is 850 cfm free air!

Downtime? Short stroke, shock-reducing all-aluminum construction and built-in wear compensation assure millions of cycles of trouble-free operation. Then, to repack, simply loosen 2 cap screws . . . twist pilot cap . . . remove pilot and valve housing. Piping is undisturbed . . . electrical connections are plug-in, wiring need not be touched.

If you're looking for better, lower cost, more dependable performance on new or existing equipment . . . before you buy any valve, be sure you see the PDQ. Call your nearby Hunt Representative today. He's listed in Sweet's Product Design File.

For more information, write for Bulletin 602. Address Dept. AH-261, Hunt Valve Company, Salem, Ohio.

HUNT

QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

HUNT VALVE COMPANY • DIVISION OF IBEC • SALEM, OHIO

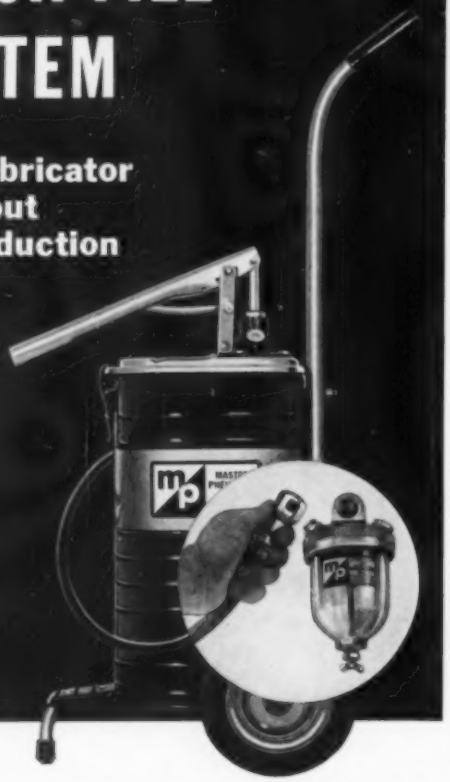
3010

NOW Cut Maintenance Costs!

QUICK-FILL SYSTEM

Fill any airline lubricator in seconds without interrupting production

- EFFICIENT: Establishes a systematic lubricator refill procedure.
- FAST: Eliminates shutting off air pressure.
- CONVENIENT: No filler caps to remove.
- ADAPTABLE: Can be used on any make lubricator.
- SERVICEABLE: Eases filling of hard-to-reach lubricators.
- SAFE: Eliminates the use of ladders.



HOW IT OPERATES:

To fill lubricator, the coupler is slipped onto Q-Cap and oil is pumped through the hose. When lubricator is filled, the coupler is removed and the operation is complete . . . in a matter of seconds . . . without loss of air or oil! M/P *QUICK-FILL SYSTEM* equipment includes: pressure fill Q-Caps, a *Hook-Tite Coupler*, a flexible wire-braid hose assembly, and a high volume oil pump.

HOW IT CUTS COSTS:

Using M/P *QUICK-FILL*, one man can fill hundreds of airline lubricators in a few hours with no production "down-time". The time and labor saved means reduced costs . . . in maintenance and production.

Contact your local representative or M/P for a detailed brochure.

NEW AIR CYLINDER LUBRICATOR

For application in the M/P *Down-Stream Circuit*—a new M/P concept which assures reliable lubrication of even the smallest cylinders.

HYDRO-JECTOR

The M/P automatic drain valve that can be installed in the bottom drain port of any compressed air filter, drain leg or surge tank.

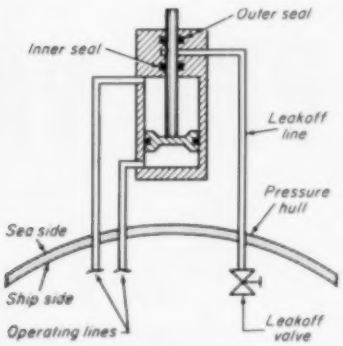
MASTER PNEUMATIC, INC.

20430 SHERWOOD • DETROIT 34, MICHIGAN • Phone: TWinbrook 3-7070

Circle **67** on Reader-Service Card

BRIEFS

• **Cylinders Lock Dredge Discharge Boom**—The 57" ID discharge boom on a dredge designed by National Bulk Carriers is mounted on an 80-foot diameter turntable that can rotate through a 180-degree angle. Alan S. Wolff, Assistant Manager, Marine Design at National Bulk Carriers, explained that to hold the boom in a fixed position, a special hydraulic braking mechanism is used. Eight hydraulically actuated C-clamps, located about the turntable, lock it in any position. When the cylinders are actuated, the clamps close down on the turntable's 2"-thick brake-disk type plate. When the shoes at the ends of the C-clamp cylinder rods contact the 2" plate, the turntable and boom are locked. Side guards absorb hydraulic cylinder side loading. One solenoid valve controls all eight cylinders. The valve is wired to the winch motor controller through a delay mechanism which prevents the motors from starting until the cylinders are released. It also prevents the solenoid valve from operating the cylinders until the motors are shut off.



HYDRAULIC ACTUATOR located outside submarine's pressurized hull has double seal with leak off line to prevent contamination and improve reliability.

• **Hydraulic Failures**—Captain D. Kern, Material Officer, COMSUBLANT, USN Submarine Base explained that next to loss of main

Continued on page 29

Circle **117**

OPENING NEW HORIZONS

. . . in economical power application

98% PLUS OPERATING EFFICIENCY
MORE POWER PER CYLINDER DOLLAR
PROVEN LEAKPROOF OPERATION
GREATEST SELECTION EVER OFFERED
SAFE UNDER SEVERE LOADS
SAFE WITH ALL KNOWN HYDRAULIC FLUIDS
SAFE UNDER TEMPERATURE EXTREMES
DAMAGE-PROOF PISTON RODS

ller HYDRAULIC CYLINDERS

Flick-Reedy . . . *Winner of "Plant of the Year" Award and "Silver Anvil" Public Relations Award*

Miller

MORE SAVINGS!

Our ultra-modern, new "Plant of the Year" with its special facilities and operating economies enable us to offer an **extra 10% price savings** on our big "stock" selection of:
Model "H" (Hyd.) Cylinders, 1½" through 8" bores;
Model "J" (Hyd.) Cylinders, 1½" through 14" bores;
Model "A" (Air) Cylinders, 1½" through 14" bores.
Strokes up to 36", cushioned and non-cushioned.

Full Details On Request

Miller Hydraulic Cylinders make impossible applications look easy. With Teflon Seals, Case-Hardened Rods (50-54 Rockwell C), Patented "Shef" Tubing End Seals, and other exclusive *standard* features, these cylinders are practically damage-proof, are ultra-dependable under pressure and temperature extremes, and provide leakproof sealing with ALL hydraulic fluids. Built to *exceed* J. I. C. Specifications, these cylinders are achieving new highs in production and operating economies in thousands of plants. Two great lines: Power-Packed Model H for 3000-5000 psi and Job-Rated Model J for 500-2500 psi. All bores, strokes and mounting styles. Big "Stock" selection for immediate shipment at substantial savings.

Write for literature.

R

MILLER FLUID POWER

DIVISION OF FLICK-REEDY CORPORATION

7N017 York Road, Bensenville, Illinois

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

no
problems
with...

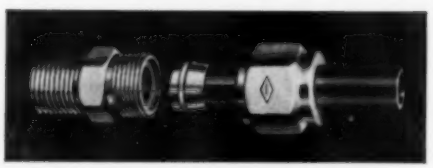
CLOSE BENDS

CLOSE BENDS

With Hi-Seal® fittings you can make tube bends close to the fitting—in fact, right next to it. Here Hi-Seal is in a class by itself.

Hi-Seal's simplified design with flareless butt joint makes this possible. The advantages? More compact lay-outs. Save on tubing. Shorten installation time by as much as 50%. Gain utmost reliability. SAVE MONEY. To get these advantages, insist on Hi-Seal.

For complete information, write for Bulletin 3108.



BUTT JOINT HI-SEAL

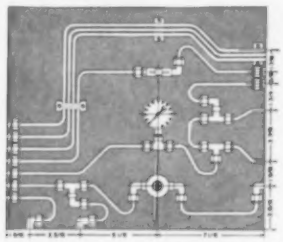
IMPERIAL EASTMAN

Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

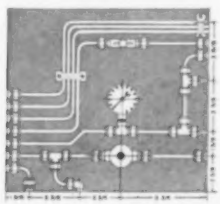
In Canada: Imperial-Eastman Corporation (Canada) Ltd., Toronto

Close Bends with Hi-Seal Save Time, Space, Tubing

Look at what you can do when you use Hi-Seal fittings:



This typical layout has "old-fashioned" tube fittings. Layout area, 257 sq. in.; 12.7 ft. of tubing; *installation time 2 hr., 34 min.*



Same layout with Hi-Seal tube fittings. Layout area reduced 32% to 175 sq. in.; tubing reduced 40% to 7.7 ft.; *installation time reduced nearly 50% to 1 hr., 20 min.!*

All this is possible because of Hi-Seal's exclusive flareless, butt joint design. This means that tube bends may be made right next to the fittings. Even direct tube connections may be made without any extra loops to allow for tube entry into the fitting.

One Fitting for the Entire System

However varied your requirements may be, Hi-Seal meets them. Available in all styles, sizes and combinations, plus a variety of metals: steel, stainless steel, brass, aluminum, titanium, Monel, etc.

Now Imperial-Eastman meets all your requirements for hydraulic-pneumatic-flow system components: tube fittings, valves, couplings, flexible and rigid hydraulic and pneumatic hose, thermoplastic tubing, tubing tools.

FITTINGS

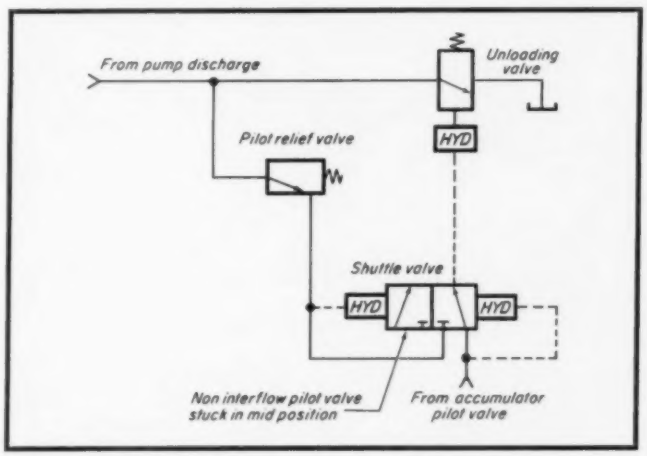
IMPERIAL-EASTMAN

BRIEFS

propulsion power, loss of hydraulic power most seriously jeopardizes a submarine's safety. Kern cited an instance of near tragic hydraulic mishap.

During the sea trials of one of the Navy's new Polaris missile submarines, a relief valve failed to by-pass and relieve system pressure. This relief valve normally directs oil flow from the main pump either to system supply, or back to the vent replenishing tank, when the accumulator is charged. The supply side of the system became overpressurized, and a 2½" pipe burst. The entire hydraulic oil supply for the main pump was dumped into the submarine's sternroom.

When the by-pass valve was examined, it showed that the shuttle valve had a mid-position where there was no flow. The shuttle valve was stuck in this position, therefore the pump could not by-pass, the accumulator was full, and there was no flow to the hydraulic operator on the unloading valve. Result: hydraulic system failure and near tragedy.



RELIEF VALVE FAILURE on submarine resulted in near tragedy. Shuttle valve was stuck in a mid-position which did not allow flow in any direction. The system became over pressurized, and blew out a brazed joint.

• **How To Improve Hydraulic Winch Design**—Areas that require improvement and development were listed by A. M. Hanke, USN, Supervisor, Replenishment at Sea and Boat Handling Section, Bureau of Ships. He cited the following objectives:

- Develop a compact, full-flow filter for the hydraulic system.
- Develop a control that will provide constant torque output regardless of load on transmission. This would provide an automatic winch tensioning feature.
- Develop a self-contained closed system to include the reservoir.
- Develop improved materials that will defy contamination.
- Increase operating pressure and speed to reduce the pounds per horsepower ratio for transmissions of 75 hp and larger.
- Combine these improvements into a factory-sealed package to permit quick removal and installation of a spare unit in the field.
- Simplify the closed system by eliminating the servo and replenishing pump.

• **Accumulator Helps Map Ocean Floor**—Cylinder type accumulators prevent failure of wire

Continued on page 32

New...from MARSH!

MARSH
Master-mite
SOLENOID VALVES

Small solenoid valves that Fill a BIG order

Yes, a series of small, direct acting solenoid valves that fulfill today's critical requirements for rugged, positive-acting tight-seating valves in types, patterns, orifice sizes and electrical ratings for use on a particularly wide variety of media including air, water, petroleum products, coolant, oxygen, hydrogen and acetylene.

They are new only in the production sense. Actually this announcement was preceded by long development and research which drew on more than 90 years of experience in instrument and valve making.

The net result is a valve that combines instrument-precision with the ruggedness that distinguishes all Marsh Valve Specialties!

Despite their small size, "Master-mite" Solenoid Valves are more rugged because the "beef" is where it counts—in the valve body. The generous, moisture-resistant coils do not overheat. Entire assembly is leak-tight at pressures up to 540 psi. Operation is positive . . . yet quiet. Valves can be cleaned without breaking connections . . . can be used in any position.

Bodies are available in either brass bar stock or 18-8 stainless steel. All parts in contact with media are stainless steel. Down to the last detail, "Master-mite" solenoid valves are designed and built to stand up and work right under the toughest conditions including vibration. They are Underwriters' approved for use on oxygen and hydrogen and as safety valves.

Read the accompanying specifications. Note the wide range of selection. Ask for bulletin containing all details.

Note these specifications

★ **Types:**	Direct acting conduit type and grommet type. Four patterns of each size and type: globe, bottom outlet, angle left, and angle right.
★ **Sizes:**	⅛" and ¼" NPT.
★ **Pressures:**	From vacuum to 540 psi. maximum.
★ **Orifice sizes:**	Ten sizes: 3/64", 1/16", 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 1/4".
★ **Voltages:**	Standard with 115 volts 50/60 cycle AC coils, but also available in 12, 24, 208, 230 and 460V, 50/60 cycle coils.
★ **Leads:**	Standard with 18", but other lengths available; also full range of connectors.
★ **Body:**	Brass bar stock or 18-8 stainless steel.
★ **Moving parts:**	All stainless steel.
★ **Seat disc:**	Synthetic rubber.
★ **Approved by Underwriters' Laboratories as a safety valve.**	

New bulletin tells the whole story

Shows all types, patterns, sizes, coils, options, etc., and contains highly useful flow curves.

MARSH INSTRUMENT COMPANY
Dept. 19, Skokie, Illinois
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

Circle **66** on Reader-Service Card

WEATHER

Fair, Mild

T-J

TOMKINS-JOHNSON TRIBUNE

★★★★★

FINAL

THE TOMKINS-JOHNSON CO. • 2425 W. Michigan Ave. • Jackson, Michigan

INCREASED PRODUCTION... CREATES PRICE ADJUSTMENT

on T-J Squair Head Cylinders

JACKSON, MICH. JAN. 3 (TP)—"Due to the tremendous initial response and the continuing acceptance and purchase of the new Tomkins-Johnson Squair Head Cylinders, it has been possible to *lower* the basic price," according to T-J personnel. In effecting this price cut, Tomkins-Johnson has again proven that acceptance of a quality product and the inevitable increase in manufacturing volume *CAN* economically justify a price reduction *WITHOUT* jeopardizing quality.

The T-J Squair Head Cylinder, an interchangeable air cylinder for any pneumatic power application, was first introduced by Tomkins-Johnson in 1958. It was an immediate success because of its availability in a wide range of bore sizes and strokes . . . as well as the standard quality features, including the new T-J Super-Cushion for air cylinders.

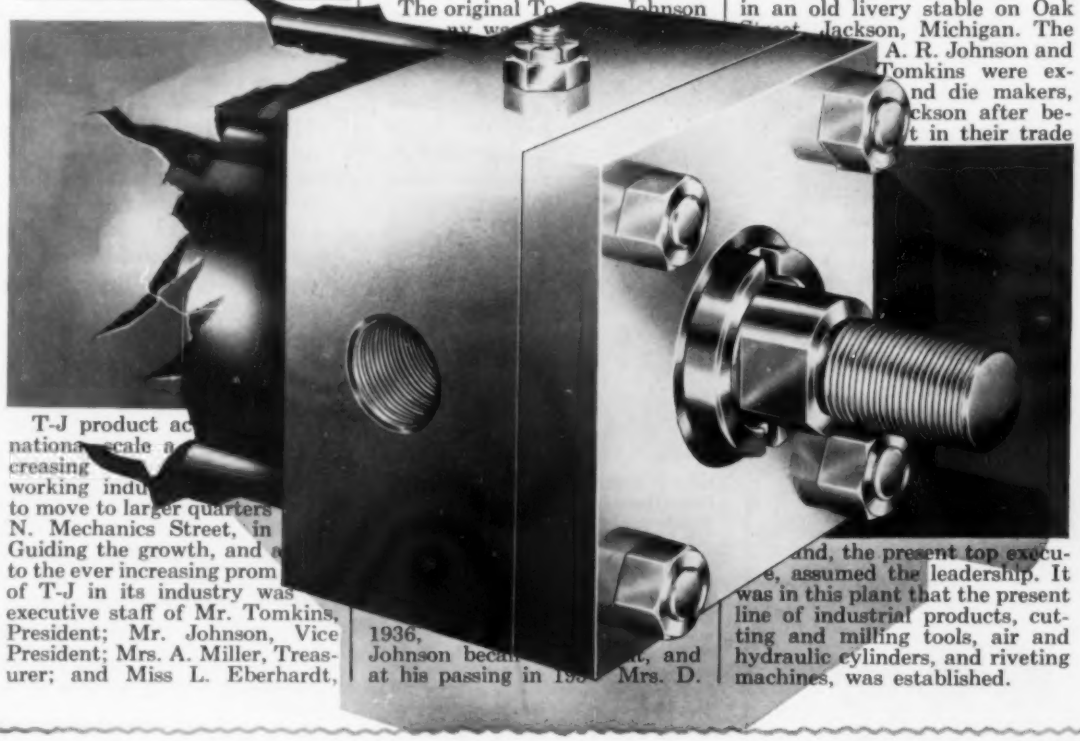
Other Standard Features

Other standard T-J features that allow the T-J Squair Head Cylinder to retain its high quality comparison over other makes of air cylinders and still give you lower price are; solid steel heads and mounting plates, hard-chrome plated bodies and piston rods, leak-proof cylinder head to body construction, heavy duty, high tensile ground and polished chrome, plated piston rod, and many more . . . STANDARD AT NO EXTRA COST.

Tomkins-Johnson, by virtue of the announced lower cost on its Squair Head Cylinder, wish to thank their customers for their initial acceptance which has been such a contributing factor in this price reduction.

T-J Produces Complete Line

Tomkins-Johnson also produces a complete line of hydraulic and pneumatic cylinders for *EVERY* power drive application . . . including the very popular Spacemaker. If you need further information or complete catalog material, write T-J direct, or request it from your T-J sales representative.



The Tomkins-Johnson Company was founded in 1917

The original To[illegible] Johnson [illegible] in an old livery stable on Oak [illegible] Jackson, Michigan. The [illegible] A. R. Johnson and [illegible] Tomkins were ex[illegible]nd die makers, [illegible]ckson after be[illegible]t in their trade

T-J product ac[illegible] nationa[illegible] scale a[illegible] creasing [illegible] working indu[illegible] to move to larger quarters [illegible] N. Mechanics Street, in [illegible] Guiding the growth, and [illegible] to the ever increasing prom[illegible] of T-J in its industry was [illegible] executive staff of Mr. Tomkins, President; Mr. Johnson, Vice President; Mrs. A. Miller, Treasurer; and Miss L. Eberhardt,

[illegible]nd, the present top execu[illegible]e, assumed the leadership. It was in this plant that the present line of industrial products, cutting and milling tools, air and hydraulic cylinders, and riveting machines, was established.

1936, [illegible] Johnson beca[illegible]t, and at his passing in 19[illegible] Mrs. D.

Circle 104 on Reader-Service Card

it's DELRIN*

Another RB&W development from Delrin plastic, this new threaded plug replaces more expensive metal plugs in many hydraulic and compressor applications.

It not only saves on cost and weight, but also does a better job. Fluid pressure forces mating threads together, creates a still tighter seal, locks threads in place.

Metal-like mechanical properties of Delrin provide excellent strength, dimensional stability, rigidity. Count also on resistance to corrosion and solvents.

Available in ⅛, ¼, ⅜, ½" pipe sizes. Send for samples.

Ask about other parts you would like custom-molded from Delrin, or other thermoplastics, in production quantities.

Write Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, New York.

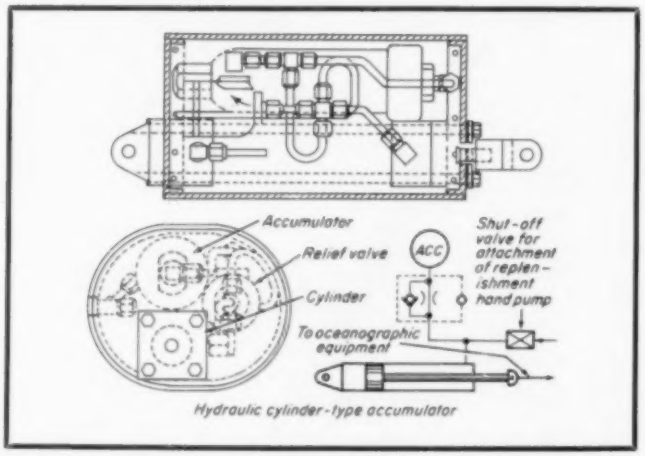
*DuPont trademark

RB&W
116th year

Circle 95 on Reader Service Card

BRIEFS

ropes which support expensive equipment to gather information about the ocean's depths. A hydraulic cylinder, accumulator, and check valve are all strapped together and piped as a closed system (see diagram). Accumulator precharge pressure is 500 psi. The cylinder head end is open to atmosphere. An orifice in the by-pass line restricts hydraulic fluid flow from the accumulator for damping. The entire assembly is enclosed in a sealed housing. The hydraulic cylinder stay bolts are anchored to the enclosure's cap and the base to hold the assembly rigidly in position. ▼▼▼



HYDRAULIC CYLINDER ACCUMULATOR protects equipment-carrying wire rope from excessive strain, shock, and possible failure.

Design Engineering Show Goes To Detroit

The Design Engineering Show will take advantage of newly opened Cobo Hall, and move to Detroit in 1961. The exposition and concurrent conference will take place May 22 through 25. The show will attract more than 400 exhibiting companies.

NEWLY PUBLISHED REFERENCE, Power Transmission Design Handbook and Directory is shown by J. C. Salette Jr. (l.) to Lee Witzenburg, vice president Cleveland Worm & Gear Div. Eaton Mfg. Co. Salette is general manager of Power Transmission Design Magazine whose editors compiled the directory. Containing more than 700 pages, the directory is being distributed nationally to design engineers and buyers whose responsibilities include design, specification and maintenance of power transmission products.

Both show and conference are devoted to the research and development aspects of new products of all types.

The machine design division of the American Society of Mechanical Engineers will sponsor the conference for the sixth consecutive year. ▼▼▼

Dynex Forms New Division

To meet new challenges in high pressure hydraulics, and to provide special engineering services in re-

Continued on page 34

Circle 63 →

TEST MACHINE at a metal fabrication plant gets air from the Le Roi 100S2 shown below. Unit also supplies air for presses, automatic and manual welders, painting machines, and automatic assembly machines.

puts your plant air supply right where you need it!

LE ROI 100-HP STATIONARY COMPRESSOR

Trouble-free air-cooled LeRoi 100S2 delivers 450 cfm of air at 125 psi — yet takes up only 20 sq. ft. of floor space.

Any way you look at it, the Le Roi 100S2 two-stage stationary compressor is your best bet to lower your cost of compressed air.

It provides cool, clean airpower. And its compactness permits installation *near the point of use*, thus eliminating excess piping and costly waste of air. If you need more air, you just install more Le Roi S2 compressors — and you can still beat the cost of centralized air systems.

The electric-motor-driven 100S2 is easy to operate and maintain. Its Dual-Control permits either constant-speed or automatic start-and-stop operation. Air cooling eliminates plumbing and water line freeze-ups . . . permits indoor or outdoor installation. Balanced design reduces vibration and noise . . . extends compressor and motor life.

Put your compressed air system on a paying basis. Investigate the complete Le Roi line of unit-type and stationary air compressors — from ½ to 100 hp. Contact your Le Roi distributor, or write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

SC-05

LE ROI STATIONARY COMPRESSORS

PORTABLE AND TRACTAIR® AIR COMPRESSORS • STATIONARY AIR COMPRESSORS • AIR TOOLS

This is a servofilter

. . . it protects hydraulic servo systems by filtering out dirt.

Only one filter element is required for phosphate ester or standard oils . . . any flow . . . 5 or 25 micron rating.

For subplate or line mounting . . . ¼" NPTF or AND-10050-4 connections.

Dimensions, application data, and specifications are in Technical Bulletin 91415. Ask for a copy.

there's a lot of magic in B & F servo components.

Boonshaft and Fuchs Inc.

HATBORO INDUSTRIAL PARK • HATBORO • PA.

Circle 14 on Reader-Service Card

BRIEFS

search and development, Dynex Inc., Pewaukee, Wisc., has organized its new Systems Engineering Division.

To introduce the division, Dynex held a conference and demonstration on hydrostatic transmissions. Wesley R. Master, Systems Engineering Div. manager, highlighted the conference with his paper on "Hydrostatic Transmissions". Over 125 executives and engineers watched high pressure hydraulics perform on special earth-moving vehicles. Guests representing companies in the mobile and industrial fields were flown in by helicopter from Milwaukee to the Dynex plant. ▼▼▼

BRIEF NOTES

MARKING TEFLON PERMANENTLY . . . is now possible with a new high-potency compound dispensed in a long nozzle squeeze bottle. Plastic Associates, Laguna Beach, Calif. announce that the fluid will not leak unless pressure is applied to the bottle which can also be used as a writing crayon.

HIGH TEMPERATURE GASKETING MATERIAL . . . A line of Viton molded compounds, reinformed with asbestos, glass, or ceramic fibers, has been developed by the Rogers Corp., Rogers, Conn. It is used for gasketing or sealing applications, that involve immersion in high temperature organic chemicals and hydraulic fluids.

HEAVY WEIGHT, HIGH-WET-STRENGTH . . . paper designed for automotive oil filter cartridge casings, has been developed by Paterson Parchment Paper Co., Bristol, Pa. Paper has a tensile strength of 80 lb per in. and a wet strength of approximately 26 lb per in.

20,000 SQ FT FACILITY UNDER CONSTRUCTION . . . Allenair Corp., Mineola, N. Y., maker of hydraulic and pneumatic equipment, announced the construction of a 20,000 sq ft addition of manufacturing and office space.

COLOR CODING . . . will make it easy to identify seats and coupling threads of hot forged steel pipe unions manufactured by the Catawissa Valve & Fittings Co., Catawissa, Pa.

BUSINESS BRIEFS

SKINNER CHANGES NAME . . . Stockholders of the Skinner Chuck Co., New Britain, Conn., voted to change the company's name to Skinner Precision Industries, Inc. Reason for the corporate name change is to reflect the broadened scope of the company's activities.

SOLENOID VALVE CO. IS SOLD . . . The assets of Carruthers and Fernandez, Inc., Santa Monica, Calif. were purchased by the Rocker Solenoid Co., Wilmington, Calif. C & F makes solenoid actuated packages and valves. Rocker is a partially owned subsidiary of Telecomputing Corp.

PALL CORP. INCREASES SALES . . . An increase of 50% in sales and 58% in earnings is reported by the manufacturer of porous stainless steel filters. Net earnings went up from $245,924 in 1959 to $388,224 in 1960. Earnings per share rose from $.56 in 1959 to $.81 in 1960.

SEALOL BUYS HYDRAULIC MANUFACTURER . . . Spartan Aircraft Manufacturing Co., makers of miniature valves and hydraulic components was purchased by Sealol, Inc., Providence, R. I. Spartan will continue to operate its Yonkers, N. Y., plant as a subsidiary of Sealol.

SANDERS ASSOCIATES EXPANDS . . . Purchase of a 50,000 sq ft production and engineering facility in Plainview, L. I. was announced by Sanders Associates, Nashua, N. H. Acquisition of a second plant in eastern Massachusetts is under negotiation.

VICKERS® Hydraulics and Alternating Current • keep capital investment low • speed cargo handling

Take advantage of Vickers hydraulics when you design or build a vessel. It offers the *infinitely variable speed control* needed for cargo handling *plus* savings that result when AC current is used exclusively on a vessel.

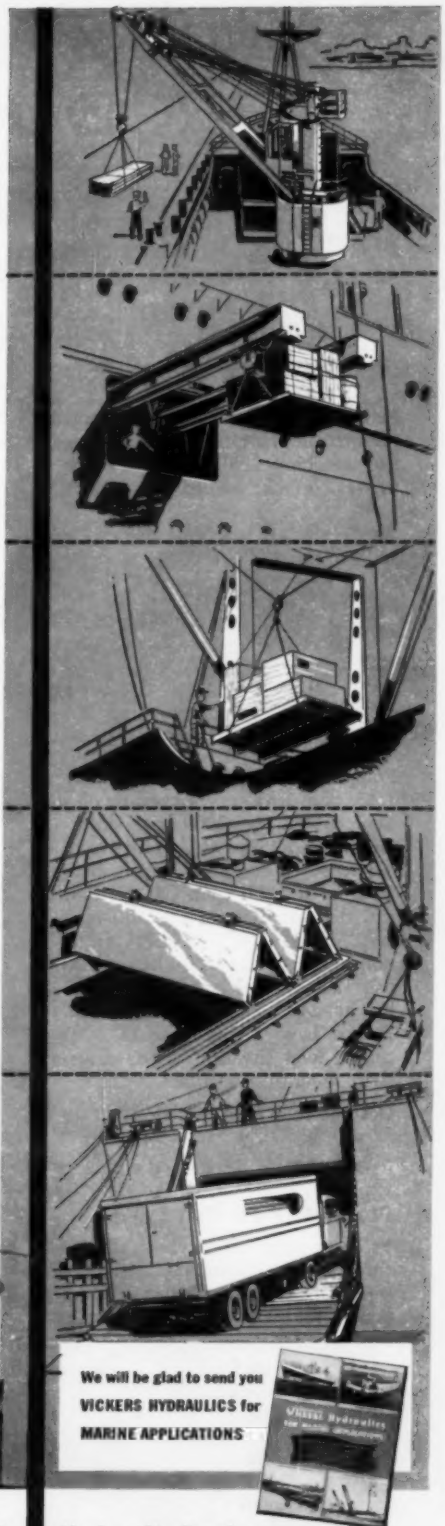
Hydraulics reduces electrical investment — With hydraulics and an all AC system, generators are simpler and less expensive. Dual generator systems, complicated switchboards and switch gear are automatically eliminated. Less wiring is required. Motors, appliances — even lamp bulbs — cost less.

Hydraulics speeds cargo handling — Users have proved that more cargo can be moved per watch with hydraulically powered handling equipment. The reason? Acceleration and deceleration is faster, smoother than any other drive. Reversal is virtually instantaneous. Infinitely variable speed control is an inherent characteristic of these drives.

Hydraulics improves space utilization — Per unit of bulk or weight, hydraulic units give *more power* than any other drive. Thus, cargo-handling equipment can be extremely compact. Furthermore, the valuable below-deck space required for operation of old style variable speed devices can be released for cargo.

Hydraulics permits design flexibility — Hydraulic motor (or pump) can be mounted in any plane. Shafts can be horizontal, vertical or at any angle. Pumps can be located remotely. Steel tubing between units is run like cable — around corners or through bulkheads.

Vickers has engineered hydraulic systems for practically all of the modern cargo-handling devices from conventional winches to "lift on-lift off" gantries. This experience is available to you. A team of hydraulic specialists is "on call" to work directly with your engineers. Phone, wire or write today!



We will be glad to send you VICKERS HYDRAULICS for MARINE APPLICATIONS

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Marine and Ordnance Department
WATERBURY 20, CONNECTICUT

Hydraulic Products for Marine and Ground Defense Applications

MO-216A

DISTRICT SALES OFFICES: DETROIT, MICH. • EL SEGUNDO, CALIF. • MEDIA, PA. • SEATTLE, WASH. • WASHINGTON, D. C.

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

PISTON PUMPS, MOTORS

Fixed displacement axial piston pumps and motors for the industrial machine field. Units are easy to service, have reversible rotation.

Pump displacement is .72, 1.09, 1.45, and 1.81 cu. in. per revolution. Rated at 3000 psi, intermittent to 3500 psi. Capacities from 3.3 to 8.5 gpm at 1200 rpm; 5 to 14 gpm at 1800 rpm. Largest unit can deliver 18 gpm at 2400 rpm max. Motors have theoretical torque ranges of 11.52 to 28 lb.-in. per 100 psi. Largest motor will deliver 28 hp at 2400 rpm and 3000 psi. Pumps have 1" NPT or 1¼" OD tubing inlet thread. Various driveshaft mountings available.

Designation: C3F Series—*Webster Electric Co., Racine, Wisconsin.*

Circle **300** on Reader-Service Card

PLASTIC PIPE CAPS

Protect exposed external end threads from damage and inside of pipes from contamination. Color coded for easy identification. On

internal threads, just a push and the pipe is protectively sealed. Closures extend beyond threads. Offers protection during painting, dipping, and handling operations.

Specifications: ⅛" to 2" nominal pipe and conduit size.

Designation: 600 Series—*Clover Industries, Inc., Tonawanda, N. Y.*

Circle **301** on Reader-Service Card

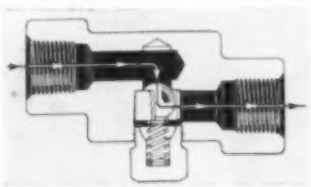
LOW PRESSURE SOLENOID VALVE

Solenoid valve has forged brass body and bonnet, and soft composition disc. Designed to handle gas to industrial and commercial power boilers and furnaces. Can be used in any low pressure control system. ¾" pipe connections. *Automatic Switch Co., Florham Park, N. J.*

Circle **302** on Reader-Service Card

OIL, AIR CHECK VALVE

Hydraulic, pneumatic check valve has sensitive ball check in forged body. Provides full flow in one direction. Instantaneous checking in the other. Oversize internal passages and unrestricted ports insure maximum fluid flow and minimum pressure drop through valve.



Specifications: ⅛" to ¾" pipe or tube sizes. Operating pressures: aluminum, 3000 psi; steel and stainless steel, 5000 psi.

Designation: Auto-Ponent Check Valve—*Auto-Ponents, Inc., Bellwood, Ill.*

Circle **303** on Reader-Service Card

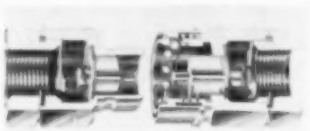
PRESSURE GAGE PROTECTOR

Protects pressure gages from damaging effects of pulsating pressures or corrosive chemicals. Diaphragm separates measured fluid from gage measuring element. Space above diaphragm is filled with viscous, non-freezing liquid which transmits measured pressure to the gage element. Not necessary to unscrew gage to fill top chamber or perform maintenance. Gages equipped with pulsation dampener can be used with fluid temperatures 50 to 100 F. *U.S. Gage, Div. American Machine & Metals, Inc., Sellersville, Pa.*

Circle **304** on Reader-Service Card

QUICK CONNECT COUPLER

Spray is eliminated when connecting or disconnecting a valved coupler plain nipple combination. Uses a positive metal-to-metal stop



when valve is closed. This controls compression and displacement of the valve seal. Extra O-ring on coupler prevents spray when there is internal pressure on one side of the coupling. For high pressure, low pressure gravity flow and vacuum systems.

Specifications: Sizes ¼" to 6". Seals made of steel, brass, aluminum, 303 and 316 stainless. Plated.

Designation: ES series—*Snap-Tite, Inc., Union City, Pa.*

Circle **305** on Reader-Service Card

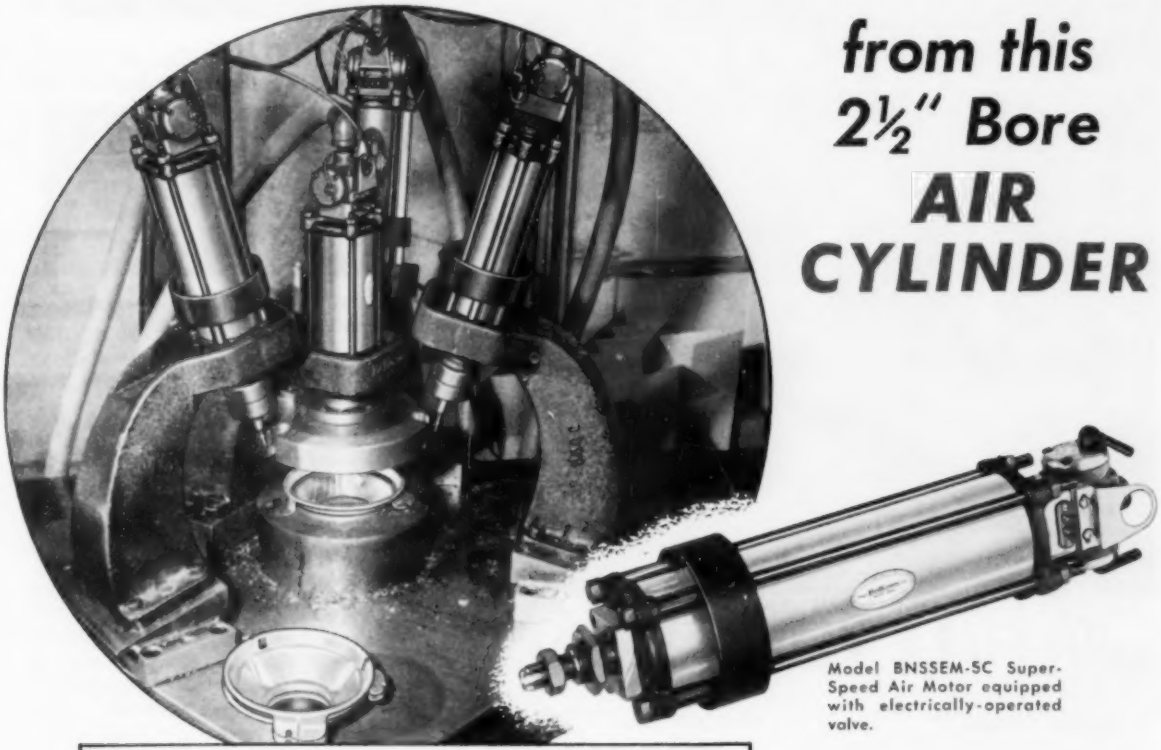
CENTRIFUGALLY CAST TUBING

Tubing meets design requirements for high-pressure, high-temperature piping, and for tubular mechanical components. Exact diameter and wall thickness can be specified. No

Continued on page 38

SUPER-SPEED·SUPER-POWER

from this 2½" Bore AIR CYLINDER



Model BNSSEM-5C Super-Speed Air Motor equipped with electrically-operated valve.

This special machine designed and built in the plant of Electro-Mechanical Products Co., clamps and pierces 3 holes in 20,000 pieces per day. It uses 3 Bellows Super-Speed Air Cylinders and a Bellows Air Motor. Set-up cost ⅓ the price of a punch press die.

This Super-Speed® Bellows Air Motor® is so powerful it can drive a 1/2" hole through 1/16" thick steel. The piston rod moves at a speed six to ten times the speed of an equivalent sized air cylinder.

That's why the Super-Speed is an ideal answer to many piercing, staking, forming, riveting, stamping, swedging and similar operations.

The Super-Speed Air Motor uses the basic Bellows integral valving system with built-in operating and speed controls. Only one air connection is required which can be flexible hose. The directional valve may be either the low-voltage (8-12V) Electro-aire® Valve or the finger tip control manual valve. One bore size, 2-1/2". Four standard stroke lengths, 4", 6", 9" and 12".

Write for Bulletin SS-5R. Address Dept. AH-261, Bellows-Valvair, Akron 9, Ohio.

More than 200 Bellows-Valvair Field Engineers are at your service

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

965-C

with FULL FLUID STEERING

DESIGN FLEXIBILITY
Allows optional and most convenient positioning of steering wheel. Eliminates cumbersome mechanical linkage to weave around engine and along frame.

OPERATES ANY POWER ACTUATOR
Can be used with simple power steering cylinder—rotary cylinder — or hydraulic motor.

ALLOWS SOUND AXLE DESIGN
All major steering forces can be contained at proper place — the axle. No thrust members needed along frame or at cockpit.

REDUCES STEERING EFFORT AND REMOVES DRIVING SHOCK

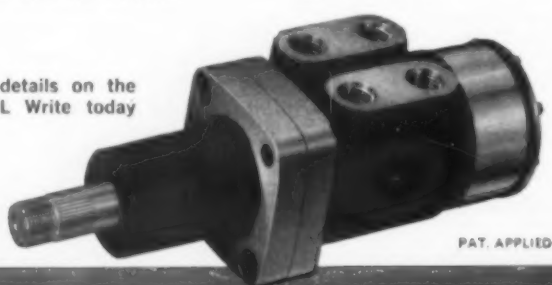
COMPACT SIZE
Wheel mounts on unit — no high forces of gear box to anchor.

ELIMINATES MAINTENANCE PROBLEMS
Minimizes lubrication points—reduces number of highly loaded thrust parts. Removes "worm chipping" — "sector scuffing" — "cam wear" problems.

NO HUNTING
Stable control removes tendency of low frequency hunting in high mass-ratio system.

REVERTS TO MANUAL CONTROL AUTOMATICALLY
In event of engine failure or power loss.

For full details on the ORBITROL Write today to . . .



PAT. APPLIED FOR

Char-Lynn

CHAR-LYNN CO.
Hydraulic Horsepower Products
Dept. HP-2
2843 26th Avenue South
Minneapolis, Minnesota
PArkway 1-5761

Circle **18** on Reader-Service Card

NEW PRODUCTS

need for special dies or patterns. Uses ceramic-lined metal flasks to

cast centrifugally molten steel or other metal compositions.

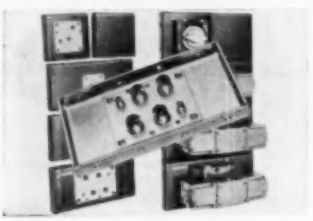
Specifications: Wall thickness from .25" to 8". Tubing diameters from 2.25" to 50".

Designation: Acipco Ceram-Spun —*American Cast Iron Pipe Co., Birmingham, Ala.*

Circle **306** on Reader-Service Card

VALVE PANEL SECTIONS

Pre-fabricated, modular, valve panel sections have integral, JIC flared-tube outlets. No intermediate fitting is required between tubing and sub-plate. Eliminates one threaded connection, and potential leakage. Reduces tubing installation time.



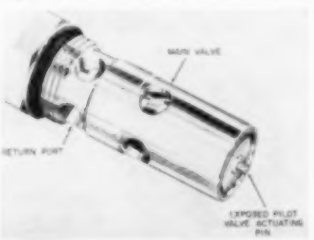
Acts as subplate and valve mounting panel. Sections can be bolted together in numerous arrangements.

Designation: Pan-Sec—*Birmingham Hydraulics, Inc., Hazel Park, Mich.*

Circle **307** on Reader-Service Card

CIRCUIT FLOW REGULATOR

Cartridge relief valve gives instant response to surge pressures in hy-



draulic circuits. Plugs into any housing which has pump pressure and provides for return to reservoir.

Pin-and-hole orifice at inlet pressure port is self cleaning. Pilot valve actuating pin exposed to line pressure at all times provides instant response to pressure surges. No internal leakage below cracking pressure.

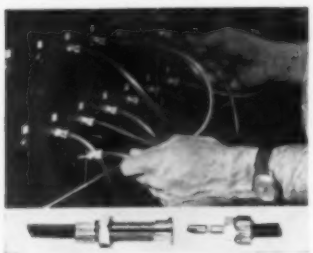
Specifications: Capacity is 30 gpm. Pressure differential less than 100 psi from trickle and full flow. Less than 50 psi between crack and closing pressures.

Designation: Model 131013—*Fawick Hydraulic-Electronic Div., Fawick Corp., Cleveland, Ohio.*

Circle **308** on Reader-Service Card

FLUSH MOUNT DISCONNECT

Miniature coupling for flush mounting for test set-ups, panel boards,



bulk-heads. Locking mechanism has fast, one-hand connecting or disconnecting of air supply. Design has flexibility of telephone switchboard. Couplings mounted on panel boards ¼" to ¾" thick.

Specifications: Working pressure 100 psi max. Socket and plug to fit ¼" OD Tygon or Polyethelene tubing. Weighs less than one ounce.

Designation: Brecoway—*Perfecting Service Co., Charlotte, N. C.*

Circle **309** on Reader-Service Card

HYDRAULIC CYLINDER CUSHIONS

High speed, self-regulating, floating cushion for hydraulic cylinders. Cushion permits faster cycling. In high speed cycling, floating cushion plunger acts as an extra check valve. This allows comparatively large volumes of fluid to enter cylinder around piston rod. Also speeds up start of cylinder stroke coming out of cushion, and eliminates a ball check assembly. At high speeds, shock and pounding are eliminated. At slow speeds effective cushioning is assured.

Specifications: 1-¾" through 14" ID.—*Miller Fluid Power Div., Flick-Reedy Corp., Bensenville, Ill.*

Circle **310** on Reader-Service Card

Continued on next page

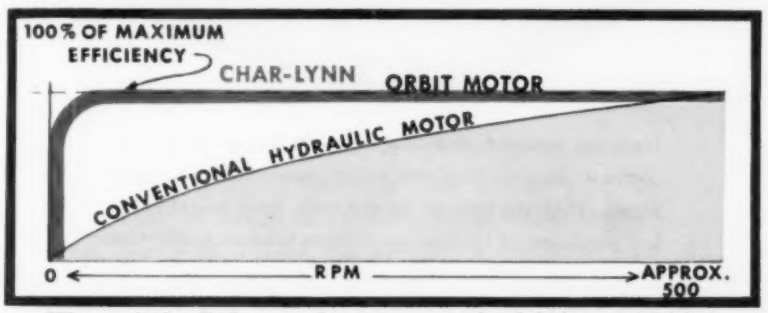
You've never seen a motor like this!

PAT. NO. 2,821,171

A High Torque, Low Speed Hydraulic Motor

It's Here—A NEW concept in fluid power mechanics has brought about the development of a totally new fluid motor—A *High Torque—Low Speed* motor.

These motors open up complete new areas for design, never before possible. They offer a practical and economical hydraulic solution to the age-old problem of providing High Torque at Low Speeds for constant and variable speed drives—hydrostatic transmissions and remote controls *without* bulky, costly mechanical drives and gear reducers.



Whereas hydraulic losses make some conventional designs prohibitive at the lower speeds, Char-Lynn ORBIT MOTORS maintain high efficiency over the complete operational range.

- Speeds from 0—800 RPM
- Torques to 3300 inch lbs.
- Starting torque substantially equal to running torque
- Fully reversible — instantaneous starting—stopping
- Only 3 moving parts
- 4 types of mountings available
- 3 port sizes—7 power element selections
- Compact—lightweight
- Eliminates costly and complicated power transmissions
- High volumetric and overall efficiency

Write for complete 8 page brochure on ORBIT MOTORS

Char-Lynn

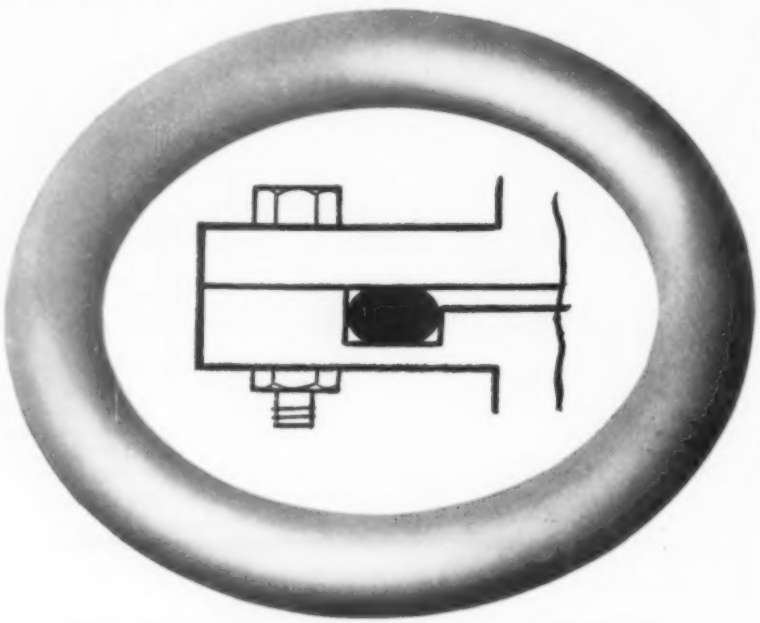
HYDRAULIC HORSEPOWER PRODUCTS

2843 26th Ave. So., Minneapolis, Minn.
PA 1-5761

Circle **119** on Reader-Service Card

R/M CAPABILITY PRODUCES O-RINGS OF TEFLON*

for seals with broad chemical resistance in temperature range from −100° to +500°F



Here are compact, double-acting seals that really fit into compact designs. They are much more than just space-savers. They are resistant to extrusion, have an extremely low coefficient of friction that reduces breakaway effort on slow-moving reciprocating and rotary equipment. They resist most chemicals, including exotic fluids and gases, have a serviceable temperature range from −100°F to +500°F and therefore are adaptable to a wide range of applications. They are generally recommended for use as static seals.

R/M O-rings of Teflon are available in a wide range of sizes to meet every requirement. R/M's Plastic Products Catalog gives complete information. Write for your copy.

*Registered trademark for Du Pont fluorocarbon resins

RAYBESTOS-MANHATTAN, INC.

R/M PACKINGS

PACKING DIVISION, PASSAIC, N.J.

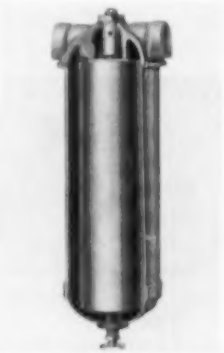
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **90** on Reader-Service Card

NEW PRODUCTS

POROUS METAL FILTER

For efficient filtration of corrosive, high temperature, high viscosity fluids. Resistant to corrosive action and high temperature of liquids and gases. Free from media migration under high differential pressures, vibration, or thermal shock. Large percentage of voids provides high dirt-holding capacity and economic flow rates with high-viscosity fluids.



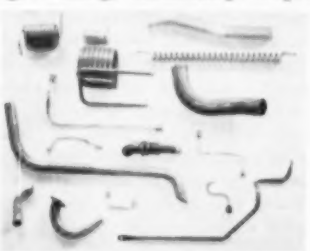
Specifications: Available in uniform 40, 20, 10, 5 and 2 micron particle-retention ratings.

Designation: Model SS B 10.– *Commercial Filters Corp., Melrose, Mass.*

Circle **311** on Reader-Service Card

TUBE FABRICATION

Fabrication of tubing for hydraulic, pneumatic, or refrigeration applications. Services include: cut-off, bending, coiling, flaring, beading, swaging, flattening, notching, trimming, drilling, welding, soldering, brazing, assembling. Repre-



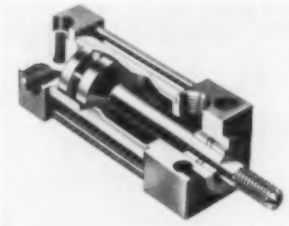
sentative items shown. *Coventry Mfg. Co., Inc., North Pelham, N. Y.*

Circle **312** on Reader-Service Card

MIDGET AIR CYLINDERS

Air cylinder for 200-psi operation. Small enough to be held in hand.

Standard stroke range to 12" in double acting models. Spring return models also available. Ideal for small cylinder applications requiring compactness and mounting versatility. Clevis and flange attachments optional. One piece pis-



ton and stainless steel piston rod are brazed.

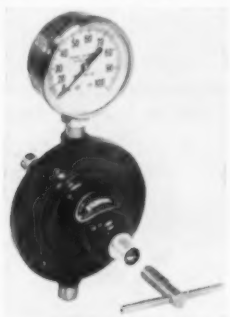
Specifications: ¾", 1", and 1-¾" ID.

Designation: Series S Midget-Air. —*Hannifin Co., Div. of Parker-Hannifin Corp., Des Plaines, Ill.*

Circle **313** on Reader-Service Card

METERING LINE REGULATORS

Metering regulators for common gases such as argon, helium, carbon dioxide, nitrogen, and others. Regulators provide sensitive control. Used for industrial and laboratory pipe lines. Equipped with ¼"



pipe thread inlets to avoid accidental connection to high pressure cylinders. Will pass 0 to 100 cu ft of gas per hour.

Designation: Series L-40-AR—*The Harris Calorific Co., Cleveland, Ohio.*

Circle **314** on Reader-Service Card

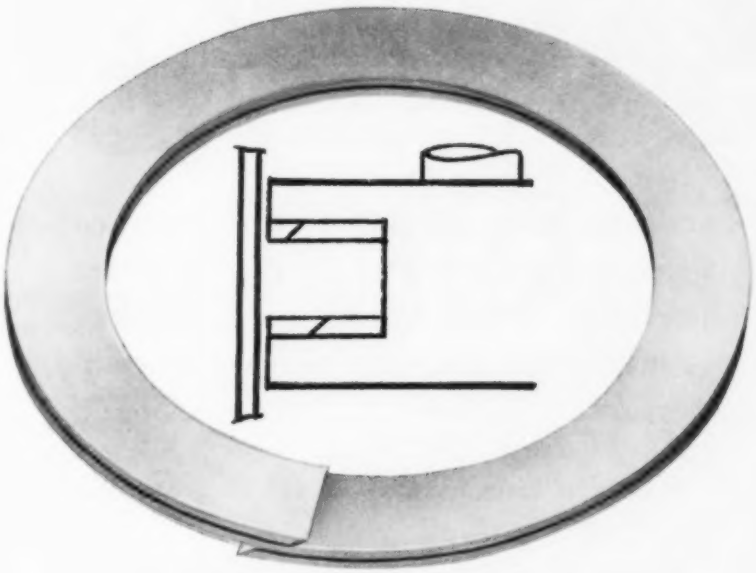
PNEUMATIC VALVES

3-way and 4-way air valves rated at 1000 cpm continuous duty. Intermittent to 2100 cpm. Valve design lengthens coil life. Short solenoid plunger stroke (3/32") improves valve performance. Friction reduced in pilot and main valve members. Mounted on sub-base for easy

Continued on next page

R/M CAPABILITY PRODUCES BACK-UP RINGS OF TEFLON*

to prevent O-ring extrusion at pressures to 3000 psi



These R/M spiral back-up rings of Teflon prevent elastomer O-ring extrusion. They have a low coefficient of friction, resist most chemicals over a wide temperature range. Accurate fit and consistent performance are assured by R/M's precision machining. R/M back-up rings are available in a wide range of sizes.

R/M's Plastic Products Catalog gives pertinent information. Write for your copy today.

*Registered trademark for Du Pont fluorocarbon resins

RAYBESTOS-MANHATTAN, INC.

RM PACKINGS

PACKING DIVISION, PASSAIC, N.J.

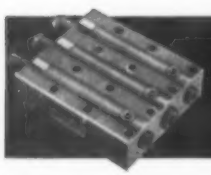
MECHANICAL PACKINGS AND GASKET MATERIALS

Circle **118** on Reader-Service Card

for DEPENDABLE HYDRAULIC PRESSURE CONTROL

Low price and high quality make FULFLO piston-type hydraulic valves a natural O.E.M. choice. The service they deliver . . . quiet, dependable and trouble-free . . . makes them ideal from the equipment users' viewpoint.

- **Screw or flange models . . . to 500 lbs. . . . for pipe sizes to 3"**
- **Steel, cast iron or brass bodies . . . brass, steel or stainless trim**
- **Fast shipment of standards . . . specials to your requirements**



NEED A "Special"?

FULFLO can engineer a special valve to your most exacting requirements. Examples of "specials" are shown in Data Book.

FOR EXTRA CONTROL CONVENIENCE

Request new, illustrated catalog of FULFLO Hand Wheel Valves . . . used where frequent pressure setting is needed.

Request complete catalog from:

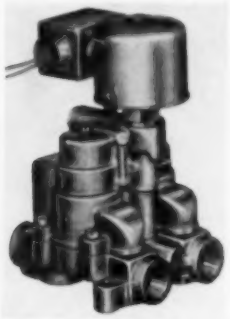
The FULFLO SPECIALTIES CO., Inc.

415 Fancy Ave., Blanchester, Ohio

Circle **35** on Reader-Service Card

NEW PRODUCTS

maintenance. Valve may be removed without disturbing plumbing.



Specifications: Rated at 150 psi. Available in ¼" to ¾" pipe sizes.

Designation: Crescent Mach 2—*Barksdale Valves, Los Angeles, Calif.*

Circle **315** on Reader-Service Card

HIGH PRESSURE LINE, FITTINGS

Pneumatic and hydraulic steel line and fittings have leak-proof, metal crush seal. Used in applications with helium at pressures from 6600 to 15,000 psi, where leakage can not be tolerated. Flow passages unrestricted in line and fittings.

Specifications: 1" fittings, and ¾" ID x 1" OD line have working pressure of 13,250 psi; burst pressure 40,000 psi. ¾" fittings and ¾" ID x ¾" OD lines have working pressure of 16,000 psi, and burst pressure of 48,000 psi.—*Pressure Components, Inc., Glendale, Calif.*

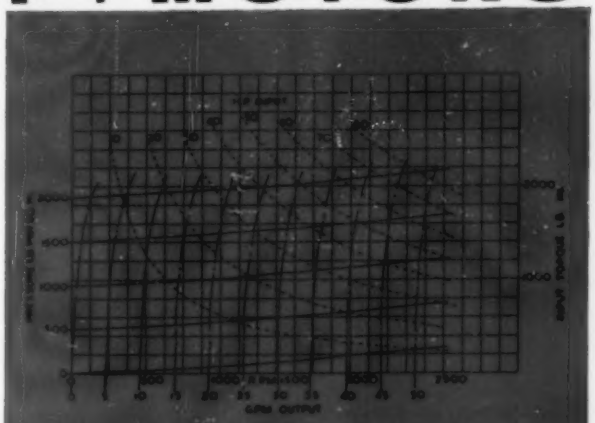
Circle **317** on Reader-Service Card

For more NEW PRODUCT reviews turn to page 104

KEELAVITE Hydraulics

GEAR PUMP / MOTORS

One of the new heavy duty gear pump/motors designed for high continuous rating.



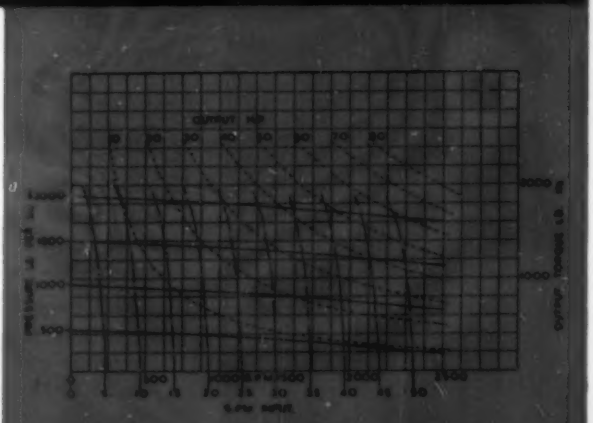
G221 GEAR PUMP

KEELAVITE GEAR PUMP/MOTORS

Within the wide range of the KEELAVITE G SERIES of GEAR PUMP/MOTORS, there is a unit suitable for any industrial use. Used as pumps, output ranges from 2.25 gpm. to 180 gpm. Motor torque ranges from 10.5 lb. ins. per 100 psi to 785 lb. ins. per 100 psi.

WHY THEY ARE BETTER

All of the KEELAVITE PUMP/MOTORS conform to a high standard of workmanship in manufacture, and are reversible without alteration in assembly. The whole range stems from six basic sizes and common components are used within each basic size. All units incorporate roller bearings.



G221 GEAR MOTOR

TYPICAL PERFORMANCE CURVES OF THE KEELAVITE G221 GEAR UNIT

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

For full details write to—

KEELAVITE Hydraulics

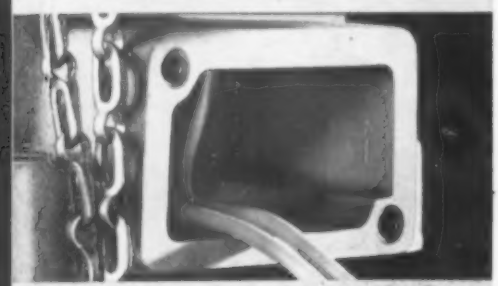
EUROPEAN REPRESENTATIVE
Mr. T. P. Keeling, Keelavite Hydraulics Ltd., Pieter de Hoochstraat 17 Rotterdam 6, Holland

KEELAVITE HYDRAULICS LTD, ALLESLEY, COVENTRY, ENGLAND
Telephone: Meriden 441

NO EXTRA-COST "ACCESSORIES" MAC VALVES ARE COMPLETE

▲ Screwdriver type manual solenoid operators are standard; ball type optional. Both have lock-in feature. Built-in seal keeps dirt and moisture out of solenoid.

▲ Pre-wired electrical plug-in wiring is standard on all MAC solenoid valves. Solenoid plugs in valve body; body plugs into base. Replace valves without changing a wire.



▲ Built-in conduit boxes on both ends of valve bases are interconnected to permit optional conduit installation. Complete with gasket and retainer chain to J.I.C. specs.

MAC VALVES

SERIES 1300
½"—¾"—1"—1¼"

SERIES 300
¼"—⅜"—½"

TOP PERFORMANCE SMALL SIZE • LOW COST

MAC Series 300 and 1300 air valves are designed around a unique spool-within-a-spool principle that has resulted in a line of valves that industry has found unequalled for performance, compactness and cost.

Performance is outstanding. MAC solenoid-air operated valves work at speeds equal to any known usage—with shorter stroke, direct operation and a highly efficient circular air flow. Tests of 30-, 40-, even 60-million cycles have proved it time and again.

Compactness surpasses performance. For example, the ⅜" port size Model 321 is about the size of just the pilot on most valves of this type. Putting it another way, these valves are about half the size of similar-use competitive valves.

On top of this, cost is far less in single-solenoid models, even lower on double-solenoid valves.

There are other savings, too. Interchangeable valve bodies, bases and solenoids; conversion of single-solenoid models to double-solenoid by simply adding a solenoid cover assembly; only three moving parts; pre-wired electrical plug-in assembly; manifold bases for ganging valves; they all give you added versatility and with fewer parts to stock.

Every MAC valve meets all J.I.C. standards. Every valve is fully tested before it leaves the MAC plant. Ask for Catalog 61 today.

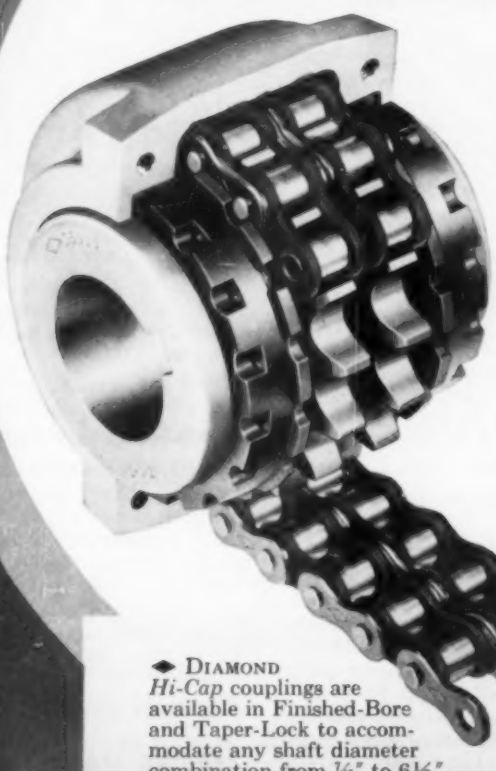
MECHANICAL AIR CONTROLS, INC.

10030 CAPITAL, OAK PARK • DETROIT 37, MICHIGAN

Circle **121** on Reader-Service Card

NOW...select flexible couplings by SHAFT SIZES

new *shaft-rated* DIAMOND *hi-Cap** ™



COUPLINGS give you

- **lower cost**
- **bearing and shaft protection**
- **quick, easy selection and installation**

* ***Hi-Cap*** **means HIGH CAPACITY**

All working parts are heat treated steel, and hardened to provide greater resistance to wear, longer service life.

◆ DIAMOND *Hi-Cap* couplings are available in Finished-Bore and Taper-Lock to accommodate any shaft diameter combination from 7/16" to 6 1/16". New *Hi-Cap* Bulletin No. 1060-C gives construction details, specifications and prices. WRITE TODAY!

DIAMOND CHAIN COMPANY, INC.

A Subsidiary of American Steel Foundries

Dept. 719, 402 Kentucky Ave., Indianapolis 7, Indiana

Offices and Distributors in All Principal Cities

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USEFUL LITERATURE

For your free copy of publications reviewed, fill in the reader service card

CUSTOM-MOLDED TEFLON

Brochure shows parts which research, planning, engineering, and production facilities have produced. Part types include standard-shaped, molded, coated, thin-sectioned, machined, filled, special, and die-cut. Chart of mechanical properties. *Sparta Mfg. Co., Dover, Ohio.*

Circle **400** on Reader-Service Card

ROLLER CHAIN

Catalog No. 760 has engineering data on flexible couplings, stock roller chain with new ARSCM horsepower ratings, and sprockets. Full information on new products in power transmission—top plate conveyor chain, heavy duty roller chain, miniature roller chain, and flexible couplings.—New ARSCM horsepower ratings.—*Diamond Chain Co., Inc., Indianapolis.*

Circle **401** on Reader-Service Card

HYDRAULIC VALVES

2, 3, and 4-way valves for 3000 psi. Variety of ports. Positive contact between rotor and seals. Spring-centered or detent-and-ball handles. ¼", ⅜", ½", ¾", and 1" NPT. Form No. W-1-2-3-4. *Weatherhead Co., Special Products Div., Cleveland.*

Circle **402** on Reader-Service Card

PUMPS, POWER UNITS, VALVES & MOTORS

First section of Catalog EJS describes hydraulic components for machine tools: vane pumps, piston pumps, directional-control valves, pressure-control valve, feed-and-rapid-traverse valve, standard and special power units, hydraulic test stands, and 1500-lb hydraulic presses. Section on industrial components describes constant-flow, rotary gear pumps, ac and dc pump/motors, piston pumps, power steering pumps, fluid motor coupled with reduction gearing, flow dividers, automotive power unit, and general-purpose power units.—*John S. Barnes Corp., Rockford, Ill.*

Circle **403** on Reader-Service Card

WELDED STEEL TUBING

Tables give dimensions and weight per foot of round mechanical tubing to 10" square, rectangular tubing to 5", and pressure tubing to 5". Decimal equivalents for fractional parts of a pipe foot. Diameters and weights for pipe sizes. *Electricweld Tube Div., Jones & Laughlin Steel Corp., Pittsburgh.*

Circle **404** on Reader-Service Card

MIDGET ROTARY ACTUATOR

Applications include instruments, computers, switches, and small valves. Use air or oil. Folder has mounting drawing and engineering data. *Ex-Cell-O Corp., Greenville, Ohio.*

Circle **405** on Reader-Service Card

FLEXIBLE BALL JOINTS

Movement in all planes up to 40 degrees angular flex or gimbal motion, plus 360 degree rotation or swivel motion. Temperatures from —320 to 1200 F. For vacuum or pressures to 4,500 psi. No metal-to-metal contact between moving parts. No lubrication. Choice of body materials and gaskets. Threaded, welding, and flanged end.—*Barco Manufacturing Co., Barrington, Ill.*

Circle **406** on Reader-Service Card

MECHANICAL SHAFT SEALS

Brochure has data, illustrations, and installation pictures. Chart of complete shaft size range. *Syntron Co., Homer City, Pa.*

Circle **407** on Reader-Service Card

REFRIGERATED AIR DRYER

Capacity of F-30 Refrigifilter is 30 scfm at 100 psig, 100 F. It has the functions of refrigerated condenser, separator, filter, and trap. Provides dew points of —15 F at 200 psig. Uses 115 vac, single-phase. 1½ psig pressure drop. 1" NPT. 35" high. Shipping weight is 200 lb. *Hankison Corp., Canonsburg, Pa.*

Circle **408** on Reader-Service Card

MEASURING INSTRUMENTS

Measure temperature, pressure, level, and flow. Condensed catalog covers pressure potentiometers, wide-range electronic micromanometer, temperature transducers, temperature standards, liquid detection systems, and mass flow systems. *Trans-Sonics, Inc., Lexington, Mass.*

Circle **409** on Reader-Service Card

ELECTRICAL SWITCHES

Catalog shows these snap-action switches: basic, miniature, subminiature, heavy-duty, enclosed limit, hermetically-sealed, and environment-free. Covers auxiliary actuators. Gives electrical ratings and operating characteristics. Discusses switch terminology. 32 pp. *Licon Div., Illinois Tool Works, Chicago.*

Circle **410** on Reader-Service Card

BENDING MACHINE

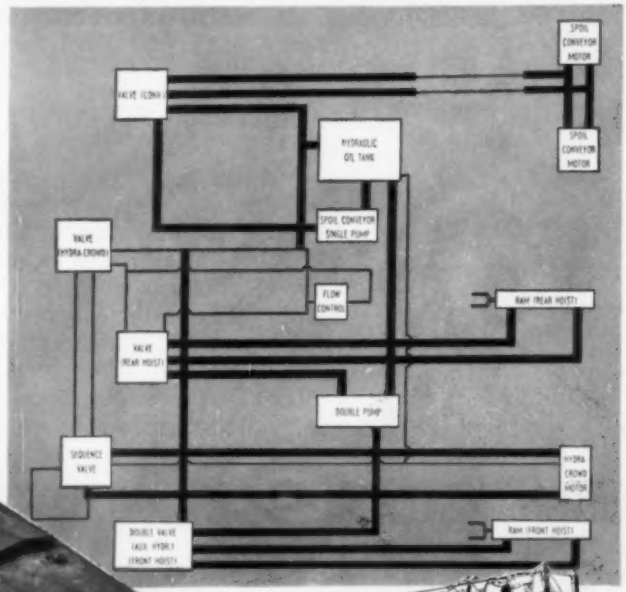
Has ten sets of dies. Produces 90-deg. elbows in ten pipe sizes from ½" to 4". ½" through 1¼" are formed two at a time. Wall thicknesses from .109" for ½" conduit to .237" for 4" size. Holds minimum straights without distorting pre-threaded ends.—*Pines Engineering Co., Inc., Aurora, Ill.*

Circle **411** on Reader-Service Card

Continued on page 48

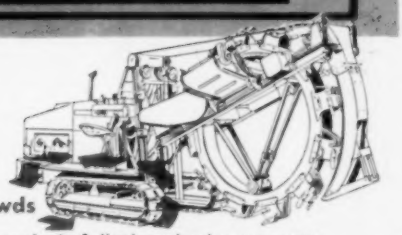
Barber-Greene's 'educated' wheel ditcher digs, crowds, conveys, hoists...

with Gates Hydraulic Hose



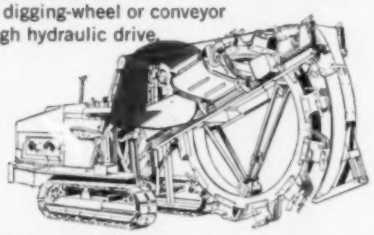
Digs

with maximum efficiency — thanks to exclusive Hydra-Crowd hydraulic transmission.



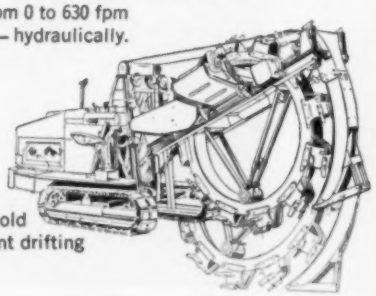
Crowds

independent of digging-wheel or conveyor speeds — through hydraulic drive.



Conveys

at variable speeds from 0 to 630 fpm with instant reverse — hydraulically.



Hoists

swiftly, positively to hold accurate grade, prevent drifting — hydraulically.

Developed specifically to "raise daily production and efficiency while lowering operating costs on ditching jobs," Barber-Greene's Model 772 Wheel Ditcher features *complete* hydraulic control of all operations — an important 'first' in the entire ditching field.

Of the Gates Hydraulic Hose used on the Model 772 Wheel Ditcher, Barber-Greene engineers have said: "Gates Hydraulic Hoses meet all of our rigid engineering specifications, and have operated to our satisfaction under the difficult conditions encountered in trenching work."

Immediately available in all major markets

Gates Hydraulic Hose — built to meet or exceed SAE specifications — is available nation-wide in wire-braided and horizontal-braided construction in a complete range of sizes, for medium-pressure or high-pressure use. Ask your nearby Gates Distributor for Gates Hydraulic Hose booklet, IH 43.

TPA 497

The Gates Rubber Company, Denver, Colorado
Gates Rubber of Canada Ltd., Brantford, Ontario

Gates

The Mark of *Specialized* Research

Gates Hydraulic Hose / Made in a Full Range of Sizes Medium-Pressure, High-Pressure

Circle **39** on Reader-Service Card

BHEW

HYDRAULIC CYLINDERS FOR TOP ON-THE-JOB RESULTS

If you insist upon top performance on-the-job, then always demand B-H-E-W products. Only B-H-E-W offers basic designs and trained specialists to adapt these quality design techniques to suit your specific application. With B-H-E-W working for you, production economies, production efficiency and quality products are your end results!

THIS IS B-H-E-W's "DUAL PILOT" CHECK VALVE. It insures positive piston rod lock in any position when the directional control valve is in neutral. You know the rod will not drift. This simplifies hydraulic line circuitry, eliminates separate pilot operated check valves, connections and lines. Your on-the-job efficiency is highly improved when you use B-H-E-W Hydraulic Cylinders!

DISCUSS YOUR DESIGN AND APPLICATION PROBLEMS WITH US!

WRITE TODAY for free Hydraulic Cylinder Engineering Reference data. 78 dimensional basic designs for general purpose and special double- and single-acting cylinders. SAVE TIME!

BH EW

INTEGRITY · CHARACTER · QUALITY

BENTON HARBOR ENGINEERING WORKS, INC.

622 Langley Avenue · St. Joseph, Michigan

Circle **12** on Reader-Service Card

USEFUL LITERATURE

HOSE & PIPE CLAMPS

Hy-Gear worm-drive clamps have no vulnerable spot welds or tangs. 9/16" band interlocks with one-piece housing. Cannot mutilate hose. Diameters from .375" to 2.375" min, .781" to 7.000" max. Catalog 1-103 also shows Snaplock worm-drive clamps, Wraplock strap clamps, and Airline economy type for small hose. *Ideal Corp., Brooklyn.*

Circle **412** on Reader-Service Card

RELIEF VALVES

Adjustable, handwheel valves for oil by-pass relief. Three series. Optional O-ring around stem and gland above O-ring. Sizes ¼"-2". Control ranges from 2 to 600 psi in 6 ranges. Bulletin shows other options. In cast iron, brass, and steel. *Fluflo Specialties Co., Blanchester, Ohio.*

Circle **413** on Reader-Service Card

PRESSURE REDUCING & RELIEF VALVE

For initial pressures of 4000 psi, WOG. No. 3851 Type F can vary controlled pressure by increments of 2-3 psi over entire externally-adjustable range. Single-seated, spring-loaded, diaphragm-actuated. Relieves at or above reduced pressure. Ranges to 1000, 2000, and 3500 psi. No stuffing boxes. In ½" and ¾". Catalog sheet has performance curve. *Atlas Valve Co., Newark.*

Circle **414** on Reader-Service Card

PROXIMITY SWITCHES

Magnetic and non-magnetic metals actuate sensing heads without physical contact. Catalog facilities matching of control amplifiers with applications. Has basic technical information. Covers economy proximity switch and time-delay proximity switch. Response curves, mounting drawings, and checklist. *Electro Products Laboratories, Inc., Chicago.*

Circle **415** on Reader-Service Card

For more reviews of FREE LITERATURE turn to page 108

WEBSTER'S NEW C3F PISTON MOTOR AND PUMP

compact, simple design ■ exceptionally serviceable!

This new hydraulic power unit — developed especially for the machine tool field — features unique application and servicing advantages. Examples: (1) small "package" to fit in close quarters — SAE "A" size mounting can be used with easy access to both mounting holes; (2) simplest axial-type piston pump on the market — fewest parts, fewer potential trouble spots, greater economy; (3) easily serviced — all critical moving parts can be readily replaced in the field. Shaft can be exchanged by disassembling seal end only; (4) unit can be disassembled and the rotation reversed in the field — can be arranged for use as a dual rotation motor; (5) variety of mounting styles — mounting plate and seal assembly is a separate piece and can be furnished in several mounting styles; (6) drive shafts are available with keyways or splines.

The C3F Series can be used as a hydraulic motor (remote rotary locations, screw feeds — anywhere an electric motor might be used) or as a hydraulic pump . . . wherever high torque and smooth, steady force are required. It is available in four sizes — from .72 to 1.81 cubic inches per revolution. Capacities range from 3.3 to 8.5 gpm at 1200 rpm; 7 to 18 gpm at 2400 rpm.

C3F SERIES

FIXED DISPLACEMENT AXIAL-TYPE PISTON MOTORS AND PUMPS

Drive: direct, gear or belt

Displacements: four sizes; .72, 1.09, 1.45, 1.81 cu. in. per rev.

Porting: Side ports — horizontal or vertical — handle 1" NPT inlet or 1¼" "O" ring straight thread

Capacity: 3.3 to 8.5 gpm at 1200 rpm
7 to 18 gpm at 2400 rpm

Speeds: to 3000 rpm

Pressures: continuous duty 3000 psi, intermittent rating to 3500

When used as motor:

Torque range (theoretical): four sizes; 11.52, 17.28, 23.04, 28.80 inch pounds per 100 psi

Output: 5.5 to 14 hp. at 3000 psi at 1200 rpm
11 to 28 hp. at 3000 psi at 2400 rpm

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Bulletin adv. H127

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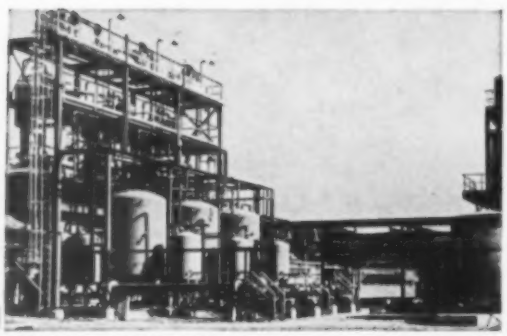

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APPLICATION ENGINEERING—Our files contain facts about hundreds of successful Cellulube applications in many industries. Celanese engineers have the experience and interest to help you make the most of these functional fluids.

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QUALITY CONTROL—Celanese zealously guards the quality of Cellulubes by a system of constant checks and controls. Physical and chemical properties are strictly maintained within exacting limits to assure you of optimum performance for fire-resistance and lubrication. What's more, Cellulubes have passed the most rigorous tests that the military and some of America's largest companies could devise.

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TECHNICAL ASSISTANCE—Our technical staff provides assistance to see that the changeover from conventional fluids to Cellulubes is made as quickly and easily as possible. In many cases, our salesmen provide all necessary conversion know-how.

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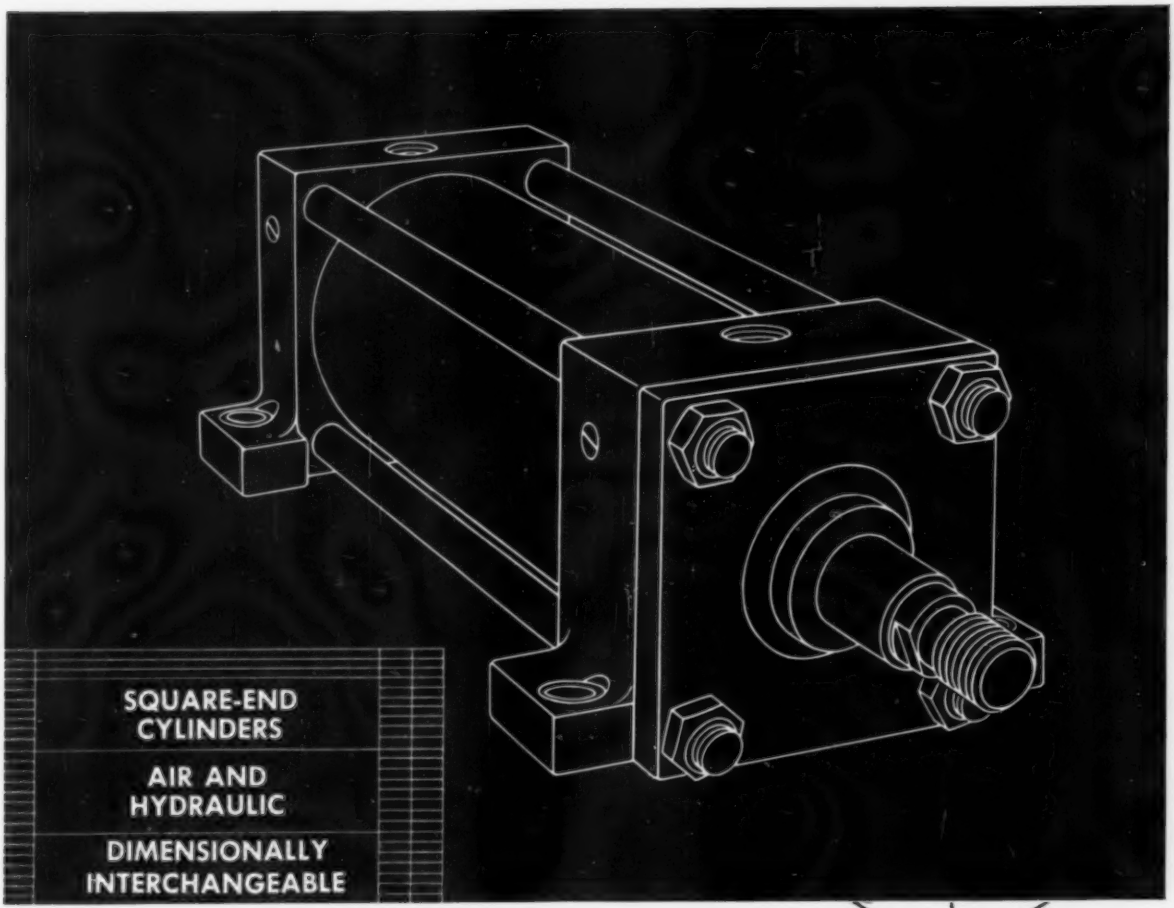
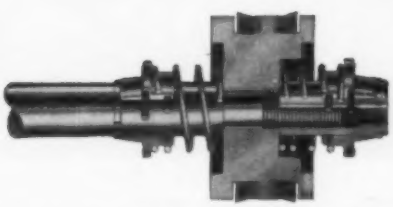


How MEAD takes the BUMP out of high-speed pistons



FULL FLOATING CUSHIONS

Detail shows two-stage feature of full floating cushion on a piston used for hydraulic pressures over 250 psi. MEAD Square-End Cylinders also offer these other design advantages:

- Seamless, hard drawn, micro-finish brass barrel for long piston seal life
- Cold drawn steel cylinder heads with all surfaces permeated with black oxide for rust resistance
- High tensile chrome plated steel piston rods
- Accurately machined rod bearing cartridge made of solid bearing bronze

Special *full floating cushions* in new MEAD Square-End Cylinders are uniquely mounted on springs rather than on solid studs. The result is a smooth, high-speed piston advance without the use of ball checks. In hydraulic units, the two-stage design of the floating cushions completely eliminates bumping. Fully adjustable from the slightest measurable cushioning effect to complete stoppage, the full floating feature also reduces cushion wear caused by impurities in the working medium. In air models up to 250 PSI and hydraulic units up to 1000 PSI, MEAD Square-End Cylinders are available in a full range of bore, stroke and piston sizes. Complete selection of mounting styles. All units are dimensionally interchangeable and conform to JIC specifications. For consultation and information on quick delivery and competitive prices, write to MEAD *today*.

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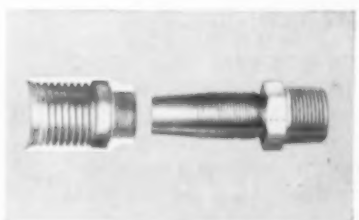
Save Hose Replacement Dollars

Using PARKER Fittings with PARKER Hose to make Replacement Assemblies Faster

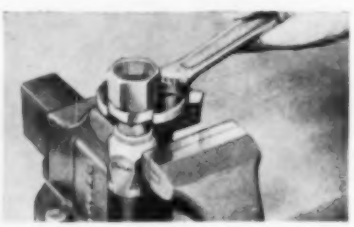
Installing Parker "Hoze-lok®" Fittings on Parker "No-Skive" Hose . . . NO SKIVING!

Installing ordinary fittings on ordinary rubber-covered hose . . . First, this messy skiving job.



Design of the "Hoze-lok" socket (left) makes the difference. The deep-tapped threads accept the **controlled thickness** rubber cover of Parker "No-Skive" Hose as they plow their way down to the wire braid of the hose. The rubber is displaced, not removed.

Just screw the hose in counter-clockwise, by hand. The rubber cover fills completely the space between each thread. It both protects and cushions the wire braid, eliminating a major cause of hose failure. A little Parker "Threadlube" is needed here.



The nipple, which is also the hose end fitting, screws in last, clockwise, in the usual way. You are now ready to make up the other end of your Parker No-Skive Hose Assembly. This method is not only faster; it gives you a better assembly. See next page.

You can install a Parker "Hoze-lok" Fitting on small-diameter Parker "No-Skive" Hose in 60 seconds. On 3/4" Parker hose, it takes 2 minutes or less. On very large sizes, allow 5 minutes per fitting. Hose replacement time is reduced to minutes the Parker No-Skive Way!

..*the* Parker No-Skive Way

Why Parker No-Skive Hose Assemblies Last Longer

BETTER PROTECTION FOR THE HOSE AT ITS POINT OF GREATEST STRESS

Most hose failures result from flexing. Ordinary hose, skived to the bare wire at the critical point where the first thread of the hose fitting bears directly on the wire braid, fails right there. As our picture shows, the leading thread of Parker "Hoze-lok" Fittings cannot reach the wire. The cushioning effect of the compressed rubber between the threads reduces the stress concentration at this point. Gripping by direct contact between the deep-tapped "Hoze-lok" threads and the wire braid occurs well within the fitting, where no flexing occurs.

Actual tests prove the effectiveness of this better design feature. Parker "Hoze-lok" assemblies on Parker "No-Skive" Hose rarely fail at the fitting, even when stressed to the burst point.

HOW PARKER DEVELOPED A BETTER HOSE TO MAKE THESE SAVINGS POSSIBLE

Parker "Hoze-lok" Fittings can be used with any hose, but you still have to skive ordinary rubber-covered hose, even with "Hoze-lok" fittings. Parker "No-Skive" Hose, however, is made to rigid specifications that limit and *control* the thickness of the cover to the exact amount of rubber that the corresponding size of "Hoze-lok" fitting will accept, when attached without skiving.

In all other characteristics, from the inner liner to the OD of the outermost wire braid, Parker "No-Skive" Hose conforms to S.A.E. specifications. In addition, because only a better grade of rubber compound can be extruded to Parker's exacting *controlled thickness* specification, the increased resistance to abrasion of the Parker "No-Skive" rubber cover results in a better hose.

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ARRANGE NOW FOR A PARKER NO-SKIVE DEMONSTRATION IN YOUR OWN PLANT OR OFFICE

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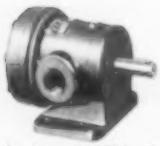
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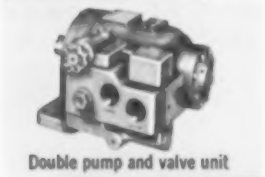
Two-stage—to 3000 psi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FEBRUARY 1961

A Course in Hydraulic Valves — PART 1

DIRECTIONAL CONTROL VALVES

Hydraulic valves can be divided, according to their function, into directional controls, pressure controls, and flow controls. This series of three articles will give you an understanding of basic designs and performance characteristics. It will present the important factors which you must be familiar with to select the best valve for a particular application, and to develop a circuit to suit the jbo.

DIRECTIONAL control valves start, stop, and direct fluid flow. They are used to extend and retract cylinders, rotate fluid motors and actuators, and sequence other circuit operations.

Directional control valves are classified according to the number of ports or connecting lines, the number of positions to which they can be actuated, the type of actuator, and the way in which fluid flows through the valve. Symbols adopted by the American Standards Association (ASA) show flow of fluid through the valve in each position. These symbols are given in the chart with corresponding valve diagrams.

PORTING

Two-way valves are essentially shut-off valves to open of close a line. They are always 2-position valves, that is they have an open position and a closed position. Either of these may be the *normal* or spring-loaded position. According to the actuator they may shift quickly from one position to the other (as with solenoid operation) or may be cam-actuated

to shift according to the speed of a cylinder or fluid motor. (deceleration valve). They may also be actuated by hydraulic or pneumatic pressure.

Three-way valves usually have only two positions but may have a center, neutral position in addition to two extreme positions. Three-way porting is usually used to control single-acting cylinders. These cylinders are extended by fluid under pressure, but are retracted by some other means, such as a spring, or the weight of the load. A common example is the lift cylinder of a fork lift truck. Fluid is forced into the cylinder to extend it, and is allowed to flow to tank during cylinder retraction.

The valve's three ports are connected to the pump, the cylinder, and the system tank. In one position of the valve, pump delivery is connected through the valve to the cylinder. The tank connection is then blocked. In the other position, the cylinder is connected through the valve to tank, and the pump port is blocked or bypassed.

Four-way valves usually control double-acting cylinders which have two ports and are extended and retracted by fluid under pressure. Two ports of the valve are connected to the pump and tank. In one extreme position, the valve connects pump delivery to the cylinder blank end and drains the rod end, extending the cylinder. In the other extreme position, the valve reverses the connections so the cylinder retracts.

Valves may interconnect more than four lines in special applications. Especially in mobile equipment systems, there may be a need for 5-way, 6-way or other porting designs.

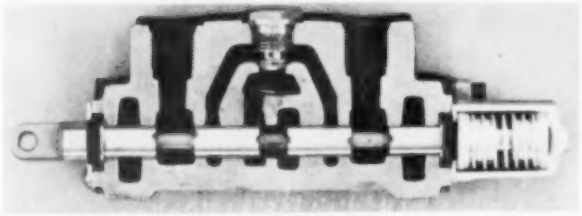
• **Center Porting**—In addition to the extreme positions, 4-way valves can also have a center position with many different porting arrangements.

A closed-center valve has all ports blocked in the center position. It can stop and lock a cylinder at some point in its stroke. Since the pump port is blocked at the valve, pump delivery is available for other circuit functions while the valve is centered. If there is an accumulator in parallel with the pump, the closed center valve prevents losing accumulator charge.

Open center valves have all ports connected to tank in the center position. They are used where the cylinder does not have to be locked in an intermediate position, and pump delivery can be unloaded to save power. In controlling a fluid motor, an open-center valve *short circuits* the motor when shifted to neutral, so that the motor can coast to a stop.

Two-position valves also have a closed or open condition as they shift through center from one position to the other. Valves which close all ports as they shift prevent any pressure drop in the cylinder line, or loss of accumulator charge if there is an accumulator in the circuit. However, they can cause pressure surges by closing off flow quickly.

Two-position valves which open all ports to tank while shifting prevent pressure surges, but may give



CLOSED-CENTER, 4-WAY SPOOL VALVE is spring-centered. Check valve prevents back flow through the pump port when the valve shifts, or if system pressure drops. *Courtesy Hydraulic Unit Specialties Co.*

an objectionable pressure drop during operation. An open center valve may be modified to meter flow as it passes through center position. Performance is then a compromise between dropping pressure to zero and getting pressure surges. This metering also helps in decelerating the controlled cylinder.

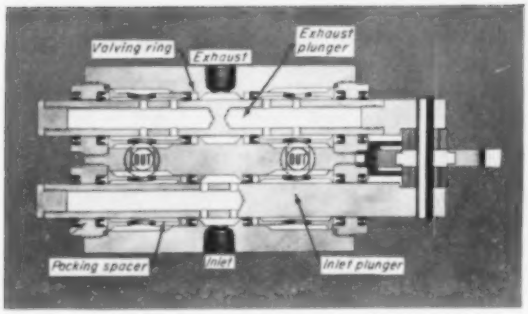
In addition to open and closed center porting, 3-position valves may have other configurations in neutral. *Tandem* valves close off the cylinder ports and connect pump port to tank in center position. They allow the pump to unload while holding the cylinder or fluid motor locked in position.

Tandem valves are frequently used in mobile equipment circuits where several valves are piped in series. The pump then supplies whatever cylinder or motor is selected by the corresponding valve. If none of the valves is actuated, pump flow is connected to tank through all the valves. In passing from one position to another, tandem valves may either open all ports to tank, or close all ports. Like other designs, this tends to cause either loss of pressure or pressure surges. A compromise between open and closed crossover can be made.

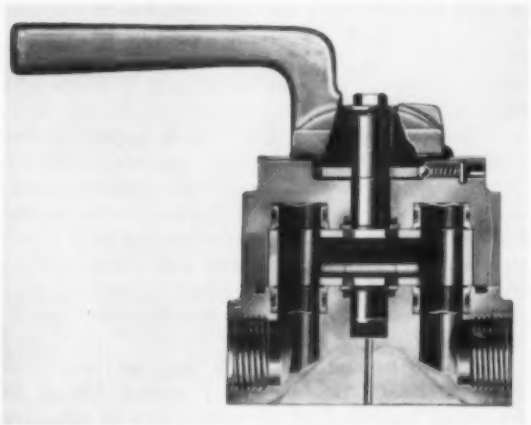
Blocking the pump port in the valve's center position and connecting both cylinder ports to tank is a design often used in pilot valves which control flow of pilot fluid to operate a larger valve. The pilot source is blocked when the valve centers and the pilot sections of the main valve are connected together through the pilot valve. Springs can then center the main valve.

Valves which connect both cylinder ports to the pump and block tank line in center position are used with fluid motors to prevent cavitation. Used with cylinders, they set up a differential circuit for fast cylinder speed. Pressures on both sides of the cylinder's piston are equal, but because of the difference in effective areas (for a single rod end cylinder) net force acts to extend the cylinder. Discharge from the cylinder's rod end passes through the valve and joins with pump delivery to the cylinder.

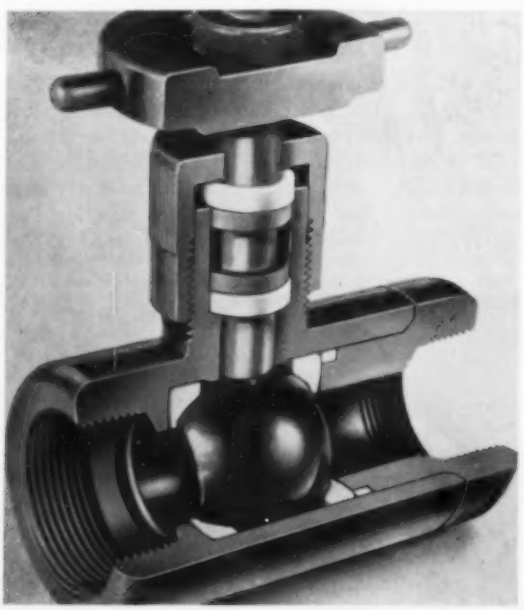
A valve neutral position with pump connected to one cylinder port, while the other cylinder port and tank port are blocked is useful where a low pressure pump serves several cylinders which are also supplied by individual high pressure pumps for high force. In neutral, the low pressure pump delivery is blocked at the valve, and the high pressure pump delivery is un-



PACKED PLUNGER VALVE has hollow plunger with drilled holes for fluid flow. U-cups seal plunger to valve body. *Courtesy Hunt Valve Co.*

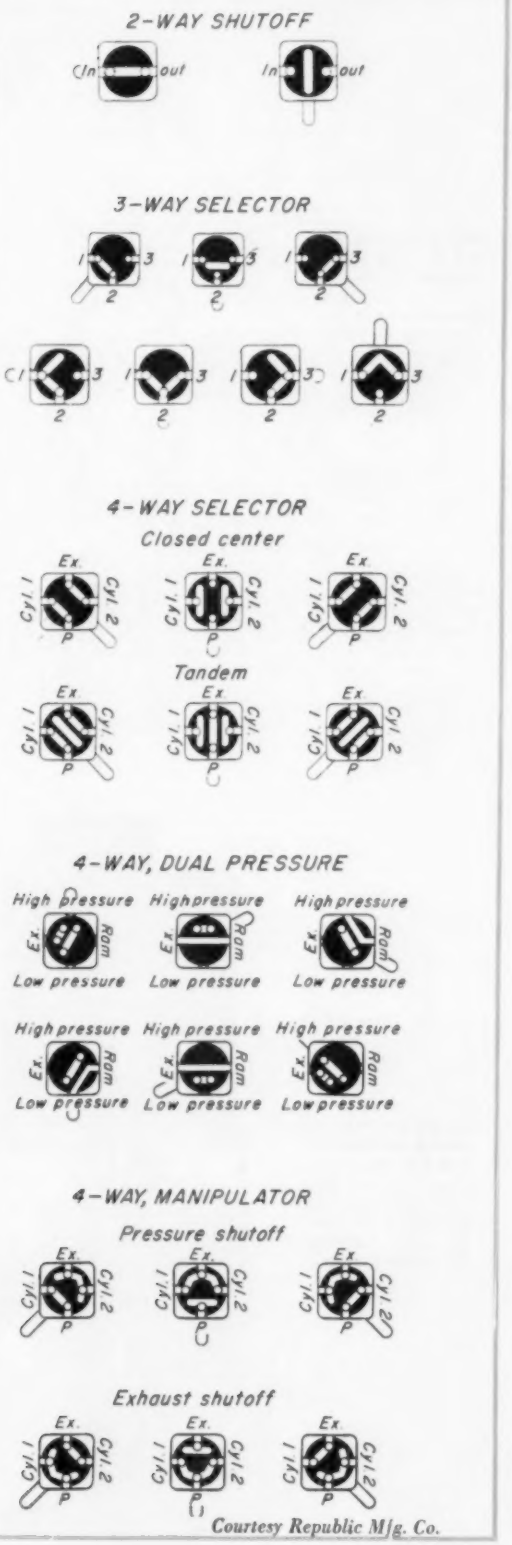


ROTARY VALVE with 4-way, open center porting. Rotary disk in this design is pressure balanced. *Courtesy Republic Mfg. Co.*

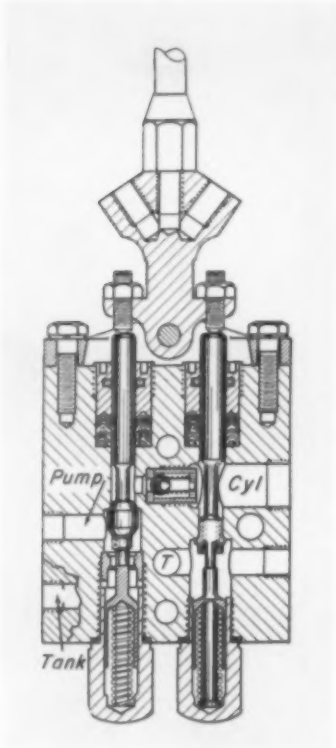


BALL VALVE has little restriction to flow, requires low turning torque. Quarter-turn opens or closes the valve. *Courtesy Jamesbury Corp.*

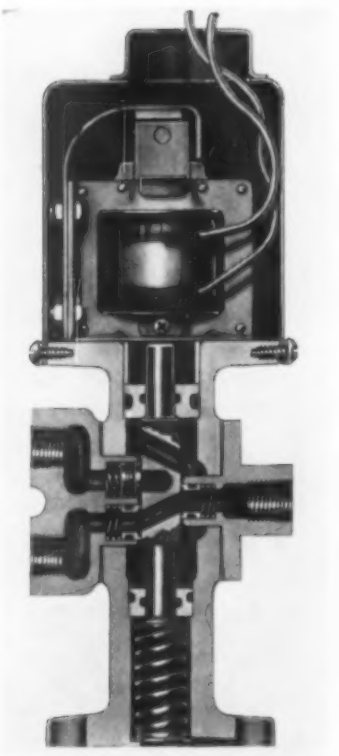
ROTARY VALVE PORTING ARRANGEMENTS.



Courtesy Republic Mfg. Co.



POPPET TYPE DIRECTIONAL VALVE is 3-way with an integral check to keep the load from dropping. *Courtesy Dynex, Inc.*



DIRECT, SOLENOID-OPERATED, 3-WAY VALVE is spring returned. Flow paths are selected by ports in the moving plate. *Courtesy Barksdale Valves.*

loaded to tank. When the valve shifts to extend the cylinder, outputs from both pumps are connected to the cylinder. When pressure builds up to the setting of the low pressure relief valve, each high pressure pump supplies its corresponding cylinder.

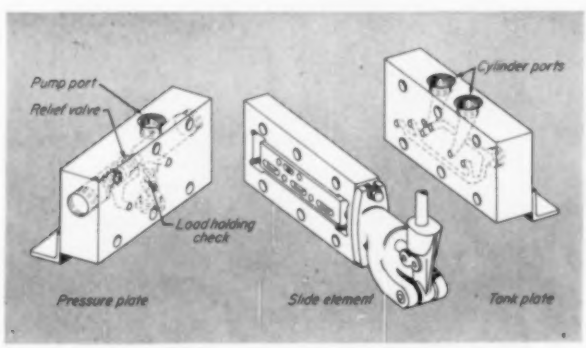
SPOOL VALVES

The wide use of this valve type is due largely to the variety of valving arrangements which it offers. Fluid flow between annular ports is controlled by lands on a sliding spool. These cover and uncover the ports. If a land is longer than the port opening, the valve is said to be *overlapped*. The spool must move a distance from center equal to this overlap before flow begins. If the lands are shorter than the port, the valve is *underlapped*, and does not close off flow completely in any position. Valves may be modified to suit particular applications by lengthening or shortening the lands to *time* the opening and closing of cylinder, pump, and tank ports in relation to each other. This may be necessary to prevent negative loads from acting on a cylinder as the valve shifts.

With sharp edge lands, valve operation is abrupt. In applications where this would cause pressure surges, or in manually controlled applications where metering control is required, the land edges can be notched, tapered, or chamfered to modify flow characteristics. Notches on the land edges reduce or increase flow slower because they act like variable orifices, opening or closing as the valve shifts.

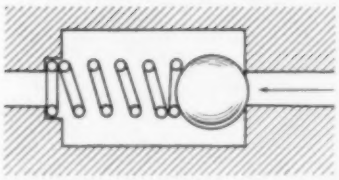
Clearance between the spool lands and the valve body determines the amount of internal leakage in the valve. Some leakage in spool valves is necessary for lubrication. Annular grooves are sometimes machined into the spool lands to help lubrication and equalize pressure all around the spool and prevent it from binding on one side of the bore. Leakage clearance is a minimum when the spool is centered in the valve.

In addition to connections made across lands of the valve spool, valve ports may be connected together through passages cored in the valve body, or through a hollow spool which has radial holes drilled between the lands. The cored body type having relatively large body passages has the advantage of superior flow characteristics which are important in larger valves.



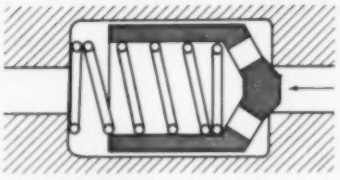
SLIDING PLATE VALVE has slide element sandwiched between pressure plate and tank plate. *Courtesy Dynex, Inc.*

CHECK VALVE DESIGNS



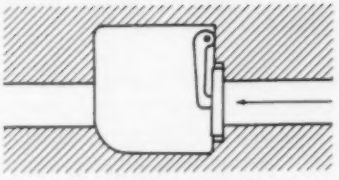
Ball check

BALL TYPE is simple and relatively inexpensive. It tends to produce turbulence which results in pressure drop and heating. Because of the ball's weight, it tends to chatter with rapid flow reversal.



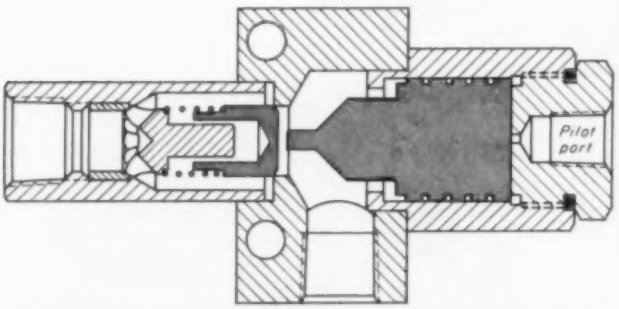
Cone type check valve

CONE TYPE has a sliding piston with a conical sealing face. Guided movement gives it better flow characteristics than ball type, and less tendency to chatter. It is useful for high pressure applications.

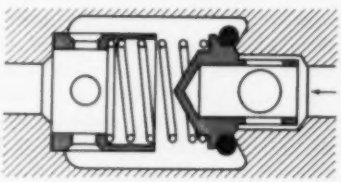


Swing type check valve

SWING TYPE has low pressure drop because of a nearly unrestricted fluid passage. Mounting position is important because it is not spring loaded. Because of the mechanical arrangement, this design is restricted to larger valves.



PILOT CHECK VALVE allows free flow in one direction and blocks reverse flow until pressure is applied to the pilot port. Pressurizing the pilot port moves the pilot piston which unseats the check valve poppet. *Courtesy Fluid Controls, Inc.*



Poppet type check valve

POPPET TYPE has a spring-loaded, guided poppet which seals with an O-ring. It has good flow characteristics with little turbulence. It can be designed with very little chatter or hammer by using damping chambers. It may be larger than ball and cone types and more expensive. *Courtesy Circle Seal Products Co.*

PACKED PLUNGER

In this design, flow is from the inlet port, through holes in the hollow plunger, through the plunger, and out through other holes to the outlet port. Each set of plunger holes is sealed by U-cups held in place by metal spacers. The U-cups are supported on both the ID and OD and are expanded against the plunger and valve body by fluid pressure. Pressure on the U-cups is balanced when they pass over the ports, thus "floating" the packer across the ports. Packed plunger valves are used in water hydraulic systems because they do not have sliding metal-to-metal surfaces which require lubrication. They are also used in soluble oil and water systems, or in oil systems requiring zero leakage.

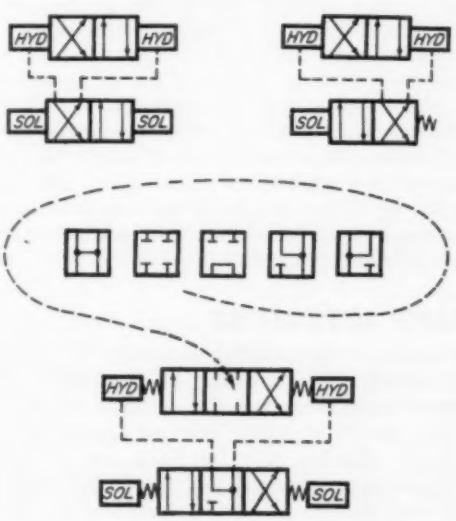
ROTARY

A flat disk with holes drilled axially inter-connects passages in the valve body. The disk may either be pressure balanced, or may have thrust bearings so that it can turn against the force of pressure on one side. The disk is sealed by a face sealing ring, which is lapped to the disk. The ring seal is spring loaded against the disk by a wave spring, and sealed to the valve body by an O-ring. The diagram shows various porting patterns that are available.

POPPET

Poppet valves are most important in water hydraulic systems where their tight sealing protects against

PORTING COMBINATIONS OF SOLENOID-CONTROLLED, PILOT-OPERATED VALVES.



wire drawing effects of water. They work effectively with the lubrication of soluble oil in water systems. Spool valves which have sliding metal surfaces require better lubrication. Although not as flexible in porting arrangements as spool valves, poppet valves can combine two 3-way units to form a 4-way valve.

SLIDING PLATE

Based on the principle of slide valves used for many years on steam engines, this valve has three main parts, as shown in the diagram. A slide element is sandwiched between a pressure plate and a tank plate which may contain an integral relief valve and check valve. The slide has cored holes and passages which mate with ports in the pressure and tank plates. Many porting arrangements are available with slight alterations to give single or multiple 3- and 4-way valves. Float, step variable, and regenerative characteristics are among the many designs possible. The valves are for pressures to 6000 psi.

CHECK VALVES

Check valves pass flow freely in one direction and shut off in the opposite direction. The four main designs are ball, cone, poppet, and swing. Valves for hydraulic applications are usually held closed by a light spring so that the valve requires a pressure of about 5 psi to open. Valves with heavier springs requiring about 65 psi to open are also available. These are usually used to maintain pilot pressure for operation of piloted directional valves.

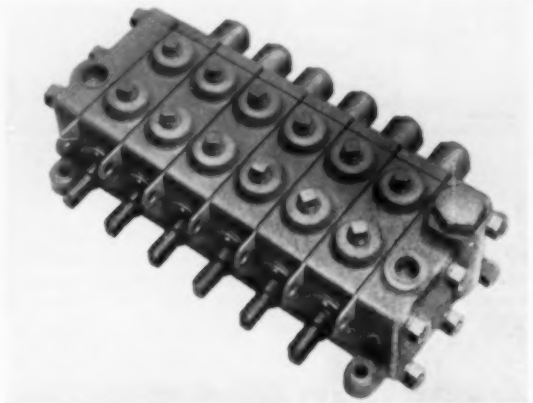
Valve ports may be either inline or at 90 degrees (angle check). The angle check sometimes has advantages for simpler plumbing when it can replace a pipe elbow.

Although a check is usually used to stop reverse flow, sometimes reverse flow is required during one phase of circuit operation. For example, a check valve might be installed in a cylinder line to prevent leakage and resulting cylinder movement. But when the cylinder must be shifted, fluid must pass through the check valve. Pilot-operated check valves have been developed for applications like this. In addition to functioning like a simple check, they have a pilot-operated piston which can force the check valve to open and allow reverse flow.

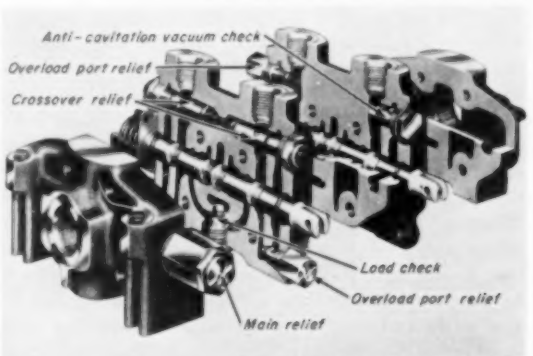
VALVE ACTUATORS

Valves can be actuated manually, mechanically, hydraulically, pneumatically, or electrically. Many styles of hand levers and foot operators are available to suit specific manually operated applications. Mechanical actuation may be either by an internal spring or by an external cam which shifts the valve from one position to another according to the cam shape.

Courtesy Parker Hydraulics Div., Parker-Hannifin Corp.



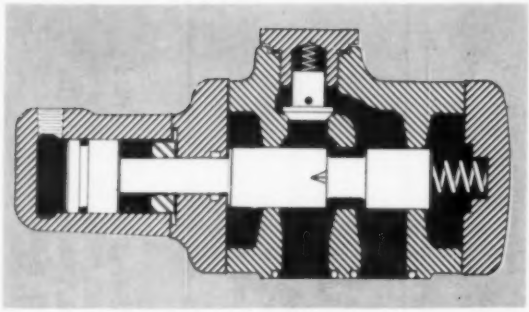
Courtesy Sundstrand Hydraulics Div.



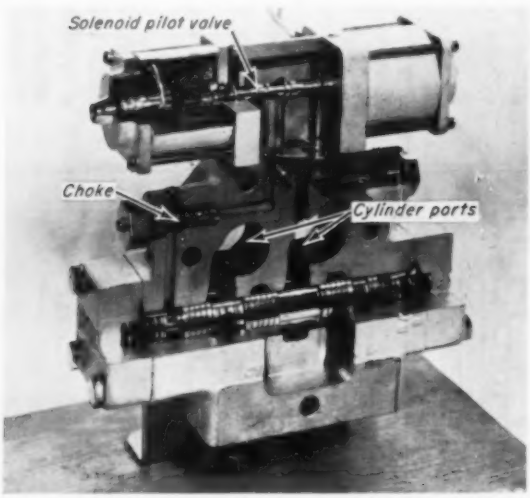
Courtesy Commercial Shearing & Stamping Co.

MULTIPLE VALVES can be cast in one body or made up of individual valve sections. They each require less piping and space than individual valves. Sectional, or stacked, valves can be altered in the field by adding sections when additional circuits are needed. With all of the valves cast in one body there can be no external leakage between valves. Lower view shows how relief valves and check valves can be incorporated into directional valve assembly.

• **Spring Loading**—An internal spring may be used to load a 2-position valve in one position (called its normal position) so that it must be actuated to the other position. Two-position valves which are not spring loaded, have no normal position, but may have detents to hold the valve in position until it is actuated.



PILOT-OPERATED SPOOL VALVE shifts when pilot fluid is ported to pilot section. Spring returns the spool when pilot port connects to tank. *Courtesy Racine Hydraulics & Machinery, Inc.*



DOUBLE-SOLENOID, PILOT-ACTUATED VALVE has three operating positions. Main valve is shifted to extreme left and right by pilot fluid from solenoid pilot valve. Springs center the spool when the solenoids de-energize. Fluid from the main valve pilot chamber is metered-out through the needle valve, called a choke. This adjustment controls the shifting speed of the main valve spool. *Courtesy Racine Hydraulics & Machinery Co.*

ASA SYMBOLS

ASA symbols are a quick and accurate means of illustrating flow paths through directional control valves. Understanding the symbols helps analyze the valve's function in a circuit.

Symbol rules (ASA Y32.10-1958) are as follows:

a. Symbols show connections, flow paths and function of component represented. They do not indicate conditions occurring during transition from one flow path arrangement to another. Further, they do not indicate construction, or values such as pressure, flow rate, and other component settings.

b. Symbols do not indicate location of ports, direction of shifting of spools, or position of control elements on actual component.

c. Symbols may be rotated or reversed without altering their meaning except in the case of lines to reservoir or vented manifold.

d. Line width does not alter meaning of symbols.

e. Symbols may be drawn any suitable size. Size may be varied for emphasis or clarity.

f. Letter combinations used as parts of graphical symbols are not necessarily abbreviations.

g. Where flow lines cross, a loop shall be used except within a symbol envelope. Loop may be used in this case if clarity is improved.

h. In multiple envolpe symbols, flow condition shown nearest a control symbol takes place when that control is caused or permitted to actuate.

i. Each symbol is drawn to show normal or neutral condition of component unless multiple circuit diagrams are furnished showing various phases of circuit operation.

j. Arrows shall be used within symbol envelopes to show direction of flow path in component as used in the application represented. Double-end arrow shall be used to indicate reversing flow.

k. External ports are where flow lines connect to basic symbol, except where component enclosure is used. External ports are at intersections of flow lines and component enclosure symbol when enclosure is used.

Three-position valves which are manually actuated may or may not have springs which load the valve in center position.

Three-position valves which are actuated hydraulically or electrically must be spring loaded to center position.

• **Pilot-Operated**—These valves are usually actuated by hydraulic pressure, but may also be actuated by air pressure. Pilot-operated, spool valves shift when pilot fluid is ported against the spool end. The spool acts like a piston which shafts when pressure builds up to overcome friction, detents, or springs.

Pilot chokes may be included in the valve construction to control shifting speed. These chokes have an adjustable needle valve to meter flow shifting the valve, and a check valve to allow free exhaust flow.

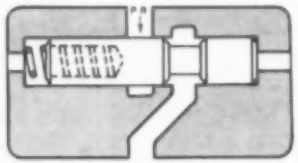
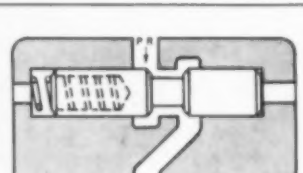
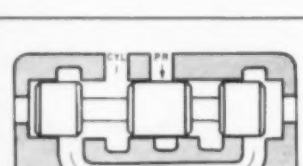
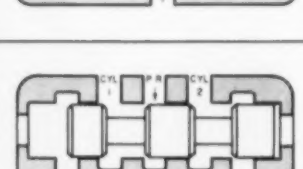
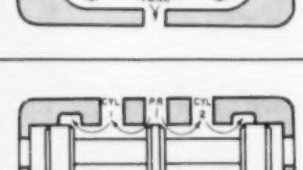
Differential control of pilot-operated valves is possible when the spool has a smaller area projection on one end. Pilot pressure is maintained on this area. Pilot pressure on the larger area at the other end of the spool shifts the valve. Removing this pilot pressure allows pressure on the small area to shift the valve.

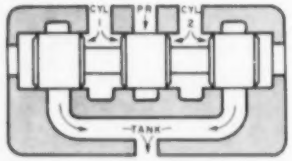
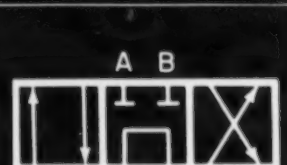
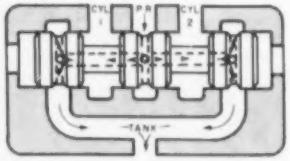
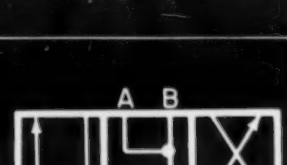
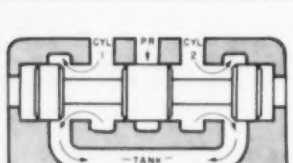
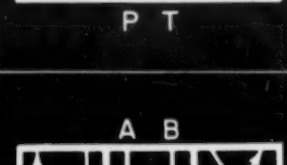
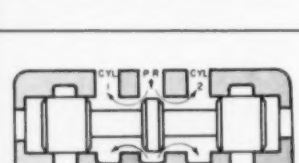
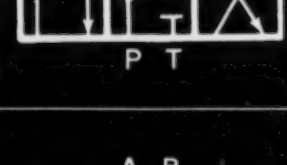
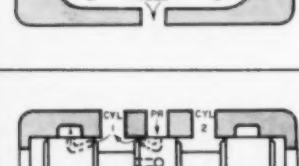
• **Solenoid-Operated**—Electrical control circuits combine with hydraulic systems through solenoid-operated valves. Control signals from timers, limit

Continued on page 79

Condensed Chart Hydraulic Control Valves

HYDRAULIC DIRECTIONAL CONTROL VALVES

2-WAY, NORMALLY CLOSED			Spring returned to closed position. Starts or stops flow from a circuit or cylinder. May be solenoid or pilot-operated. May be cam-operated to accelerate or decelerate a cylinder.
2-WAY, NORMALLY OPEN			Spring returned to open position. Starts or stops flow from a circuit or cylinder. May be solenoid or pilot-operated. May be cam-operated to accelerate or decelerate a cylinder.
3-WAY			Actuates single-acting cylinders porting pump delivery to cylinder in one position, draining cylinder in other position.
4-WAY, 2-POSITION			Extends and retracts a cylinder. Rotates a fluid motor in either direction. No provision to stop a cylinder or fluid motor.
4-WAY, 3-POSITION, OPEN-CENTER			Extends and retracts a cylinder. Rotates a fluid motor in either direction. No provision to stop a cylinder. Pump unloads to tank when valve centers; cylinder or motor is free to move.

4-WAY, 3-POSITION CLOSED-CENTER			Extends and retracts a cylinder. Rotates a fluid motor in either direction. Center position stops and holds cylinder or fluid motor, closes pressure and tank ports. Can be connected in parallel with other closed-center valves.
4-WAY, 3-POSITION TANDEM CENTER			Extends and retracts a cylinder. Rotates a fluid motor in either direction. Cylinder or fluid motor is locked in position when valve centers. Pump flow unloads through valve center-position to tank or passes through the valve to additional tandem-centered valves.
4-WAY, 3-POSITION PUMP PORT BLOCKED IN NEUTRAL CYLINDER PORTS CONNECTED TO TANK			Extends and retracts a cylinder. Rotates a fluid motor in either direction. Cylinder or motor is free to move in either direction with valve centered. Prevents starving a fluid motor during slow down with valve centered. Can be connected in parallel with other closed-center valves.
4-WAY, 3-POSITION, TANK PORT BLOCKED IN NEUTRAL CYLINDER PORTS CONNECTED TO PUMP			Extends and retracts a cylinder. Rotates a fluid motor in either direction. When controlling a single-rod-end cylinder, valve forms a differential circuit in center position for fast cylinder speed.
4-WAY, 3-POSITION, ONE CYLINDER PORT BLOCKED IN NEUTRAL, OTHER CYLINDER PORT AND PUMP PORT CONNECTED TO TANK THROUGH RESTRICTION			Extends or retracts a cylinder. Rotates a fluid motor in either direction. Cylinder or motor is locked in position when the valve centers. Pump flow is bypassed to tank, but restricted.

Valve diagrams courtesy H-P-M Div. Koehring Co.

What 3-position air valves can do

• By **EMMONS E. SMITH,** *Manager Pneumatic Div. J. N. Fauver Co., Detroit, Michigan*

A 3-position pneumatic valve is used to position a fluid power actuator—such as a cylinder—to any position along its stroke. 3-position *hydraulic* valves have been used for a long time, but only in recent years have 3-position *pneumatic* valves been used to any great degree. This paper discusses their use and the possibility that they have been over used or at least oversold.

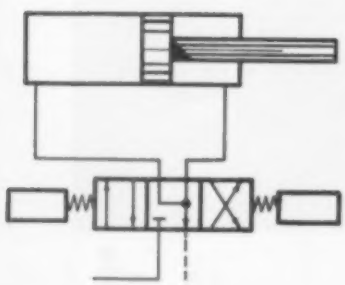
Standard 3-position pneumatic valves come in three basic center porting design: (1) supply air blocked, valve cylinder ports open to exhaust; (2) all ports blocked; (3) valve cylinder ports open to supply, exhaust blocked.

• **Valve Cylinder Ports Open to Exhaust**—In center position, this 3-position, opens the valve cylinder ports to exhaust. It is used to control a horizontally mounted cylinder. The cylinder piston rod must not be subjected to external forces when the valve is in neutral position, because with both sides of the cylinder open to exhaust, the cylinder has no means to counter either gravitational force or external mechanical forces.

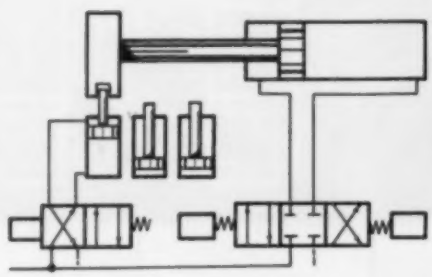
This valve is frequently used on horizontal shuttles, where the valve's midposition is simply a *wait* position. When conditions permit, it is advantageous to use this type valve because a normal amount of cylinder piston leakage can be tolerated during its operation, as is the case with a regular 2-position valve. This is not true, however, with valves that have all ports blocked in neutral position.

• **All Ports Blocked**—When a 3-position valve has all its ports blocked in center position, it is called a neutral or closed center valve. It is used to stop an actuator when the valve is shifted to center position. An elevator or hoist is a good example of such an application.

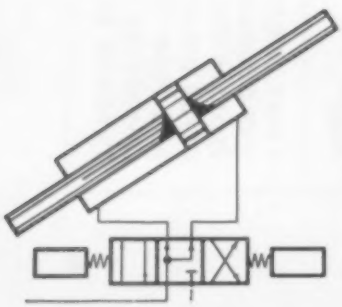
In recent years, these valves have been used most commonly in shuttle applications which normally



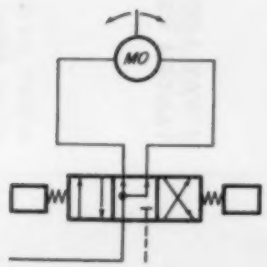
VALVE CYLINDER PORTS are open to exhaust in neutral position. Used with horizontally mounted cylinders.



ALL PORTS BLOCKED. Used to control air hoist or elevator. Locking dog stops creep.



VALVE CYLINDER PORTS are open to supply in neutral position. Require double ended cylinders which can be mounted in any position.



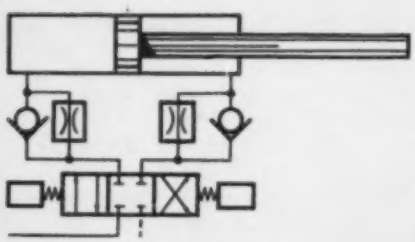
VALVE CONTROLS rotary actuator. Has excellent braking characteristics.

stop only at the end of a cylinder stroke. From a strictly operational standpoint, a 2-position valve would also do the job. The 3-position valve is more desirable in theory, however, because it has an added safety feature. In case of power failure, power cut-off by an operator, or an emergency, it stops and holds the shuttle at any point along its travel. It prevents the shuttle from returning to one of its end positions where personnel may be endangered.

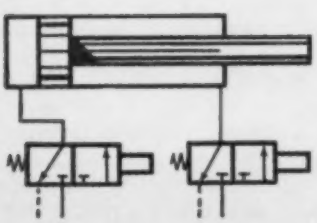
The shuttle may not stop immediately. It may bounce or reciprocate slightly because of system inertia, air compressibility, and the necessity to balance forces in the cylinder. From a safety standpoint, however, results are usually satisfactory. Once the mechanism is stopped, slow creep may still take place, because if piston seals leak, this will allow fluid to pass from the higher pressure rod-end to the lower pressure head end. This extends the cylinder. Leakage in the piping or the valve may also cause creep. Such creep is usually not considered harmful because the mechanism would move very slowly and not endanger personnel.

In some cases, 3-position pneumatic valves have been oversold as position controls for vertical or canted cylinders such as hoist cylinders. On these installations, when all components are new and bubble-tight, reasonable accuracy is possible. But after limited operation, seal or pipe leakage induces creepage and it becomes necessary to install a mechanical lock or dogs to hold positions as soon as the 3-position valve has performed its function.

• **Valve Cylinder Ports Open to Supply**—These valves connect supply air to both cylinder ports in neutral position. They are the least common. They must be used with double-rod cylinders because when both sides of the piston are pressurized, equal areas are necessary to balance the pneumatic forces and quickly bring the cylinder to a stop.



MOST 3-POSITION VALVES are used to control shuttles. Should power fail, shuttle will stop at any point in its travel.



TWO 3-WAY NORMALLY CLOSED VALVES give the same effect as a 3-position valve with valve cylinder ports open to exhaust in neutral position.

This system has good braking characteristics because line pressure supplies a positive braking force compared to the braking force supplied by residual air normally trapped and compressed in a cylinder with an all ports blocked valve. With open center valves, there is no positive braking force at all. Because of the cost of double-rod cylinders and because they are rarely used on pneumatic applications, this particular type of pneumatic valve is seldom used with cylinders. It is most popular with air rotary actuators which have equal areas in each direction, and often need to be stopped or reversed quickly.

• **Hazards of 3-Position Valves**—Although 3-position valves can improve safety in shuttle devices, in some instances air leakage can create a real safety hazard. Here is what happens:

On shuttles where travel usually exceeds 18 in., flow control valves are installed between the cylinder and the 3-position valve. These control speed by throttling exhaust flow. They are adjusted to meter correct flow with an initial pressure-volume in the cylinder. When a closed center valve stops a cylinder in mid-stroke, it traps air on both sides of the piston. If the valve does not leak, while it is in mid-position, the speed controls will still have enough volume under pressure to throttle and slow the shuttle speed, although not as effectively. However, if the valve leaks to the extent that while the shuttle sits in mid-position all the air dissipates from both sides of the cylinder, then a new hazard is created. When the shuttle is reset to one of its end positions, there is not enough air left to control cylinder speed effectively, and the shuttle slams into an end position, endangering personnel and breaking equipment. What was intended as a safety measure has resulted in a new hazard.

Air valves are available in poppet or spool construction. Poppet valves have very short strokes, have the ability to open as soon as travel beings, and do not pass through a neutral position during their travel. For these reasons, poppet valves cannot operate as 3-position valves. It is, however, possible to use a 2-position, 3-way, normally closed, poppet valve in each line to a double acting cylinder. De-energizing both 3-way valves has the same effect as shifting a 4-way open center valve to neutral. Supply pressure is then shut off and both cylinder ports are connected to exhaust. Some poppet valves have two, 3-way valves mounted on a common base, (dual three way).

If safety warrants the cost of a 3-position valve, it also warrants the cost of expert bubble-tight piping, a top-quality cylinder with a lip type piston packing and good air filtration and lubrication to extend the life of both the valve and the cylinder. From the author's experience, the 3-position valve should have "U" type seals which can compensate for wear over a period of time and give longer bubbletight life. Each 3-position valve application should be realistically appraised for these requirements:

1) Is it really necessary?
2) Will the improvement justify the increased costs?
3) Is safety a factor?
4) Does the valve truly enhance safety? ▼▼▼

Why tubing fails

• By **NICHOLAS S. HODSKA,** *Design Component Group, Sikorsky Aircraft Corp., Stratford, Conn.*

LIKE other hydraulic components, tubing may fail because of stress . . . fatigue . . . deflections . . . vibration. Here is an analysis of how each of these affect tubing life.

STRESS

Tubing loses elasticity above certain temperatures. Hardness and strength also decrease, while ductility increases. Ambient temperature increase reduces fatigue life of helical and torsional tubing configurations.

Frequently, stressed tubing will continue to deform indefinitely as temperature increases even under a very low constant. This gradual, permanent yielding under constant stress is called gradual flow, or *creep.* If it continues for any length of time it will ultimately cause tube failure. Conformability is another property that tubing materials have of flowing or creeping slightly so that the fittings can conform. Hard tubings have little conformability. Soft tubings usually have greater conformability and are therefore more desirable.

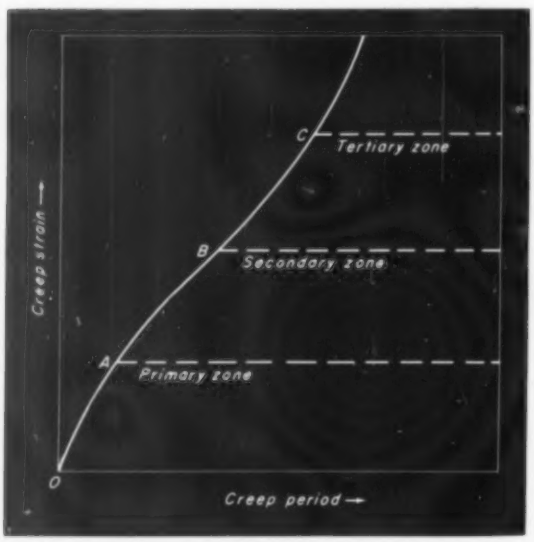


FIG. 1. CREEP STRENGTH of hydraulic tubing. Creep strain rate decreases from O to A, remains constant from A to B and increases from B to C.

Creep strength of hydraulic tube material determines maximum stress that can be applied at a given temperature to cause plastic flow to the material at a given rate as shown in Figure 1.

The region of constant strain rate (secondary creep) is often used to estimate probable deformation throughout life of the part.

Deformation rate is generally stated as a certain elongation of a test specimen subjected to a specified temperature for 1,000 or 10,000 hours. In contrast, the perceptible stress at which a hydraulic tube specimen, subjected to constant pressure, fails is known as stress-to-rupture, or bursting strength. At a given temperature, the stress-to-bursting strength decreases with an increase in the time the tube material is at elevated temperature and the ultimate strength.

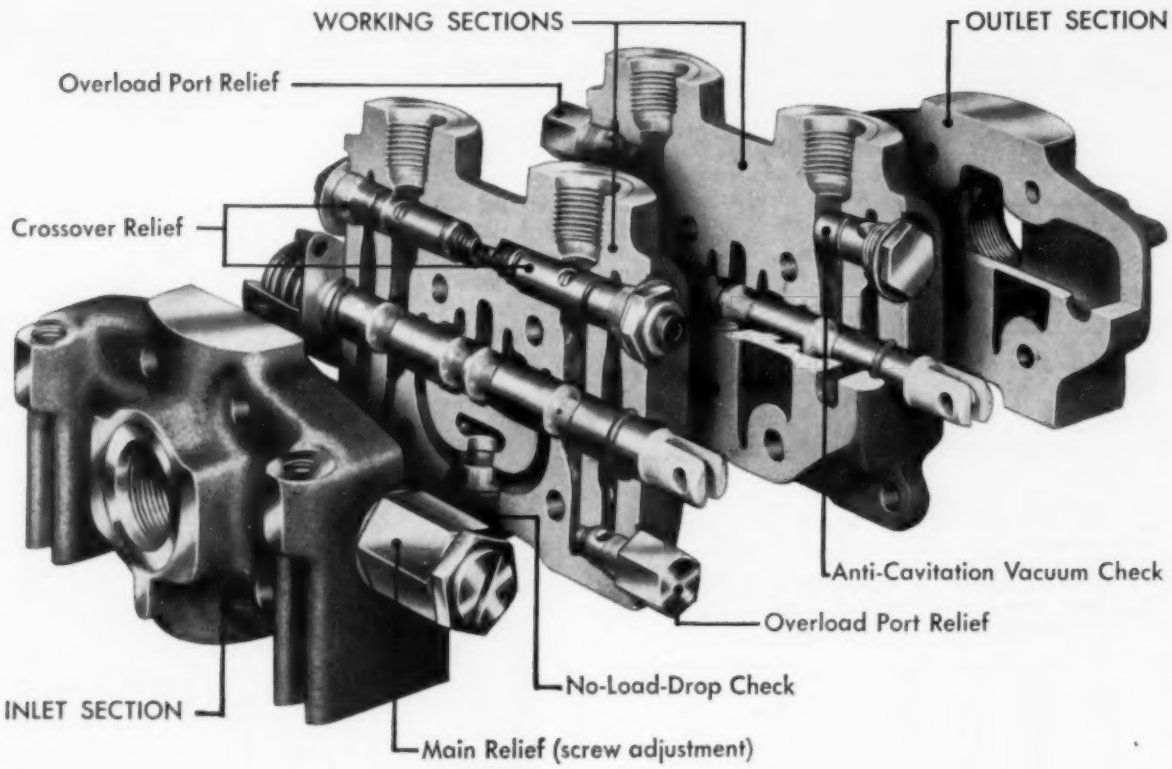
• **Using Creep Data**—Creep characteristics are significant when allowable tube deformation is limited in high temperature service. To use creep data, a minimum tubing life is first selected for a given temperature. After testing various grades of tubing, one is selected so that creep will not burst, or rupture the tubing within its required life.

The tubing layout is then designed with the permissible design stress made equal to the creep stress of the tube material. Working stress is chosen so that this total deformation will not be excessive. Since the creep test is usually much shorter than the tubing life, test data must be extrapolated and analyzed.

In addition to a diffusive, creep stress, tubing is also subjected to stresses shown in the table.

Allowable stresses are not included since they are given in current stress analysis books. To determine these stresses in a configuration made up of curved sections and straights, it is necessary to conduct a motion analysis.

The torque tube configuration is weakest along the straight section in torsion. The single helical coil tube configuration, illustrated in Figure 2, may be sectioned



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and analyzed at any point along the tubing. Shear stress exists at every cross section of the tubing along its length. Although the entire tube is under compressive or tensile load, cirtical stress is in torsional shear.

Typical Tube Stresses

INITIAL AND SIMPLE STRESSES	COMBINED STRESSES
Bending	Bending stress due to force, which is tensile on one side and compressive on the other.
Biaxial	
Hoop	
Longitudinal	Longitudinal tensile stress due to pressure.
Stress arising from interior pressures.	
Stress arising from mechanical flexure.	Torsional shear stress.
Temperature	
Transverse bending	Transverse stress due to pressure (hoop stress).

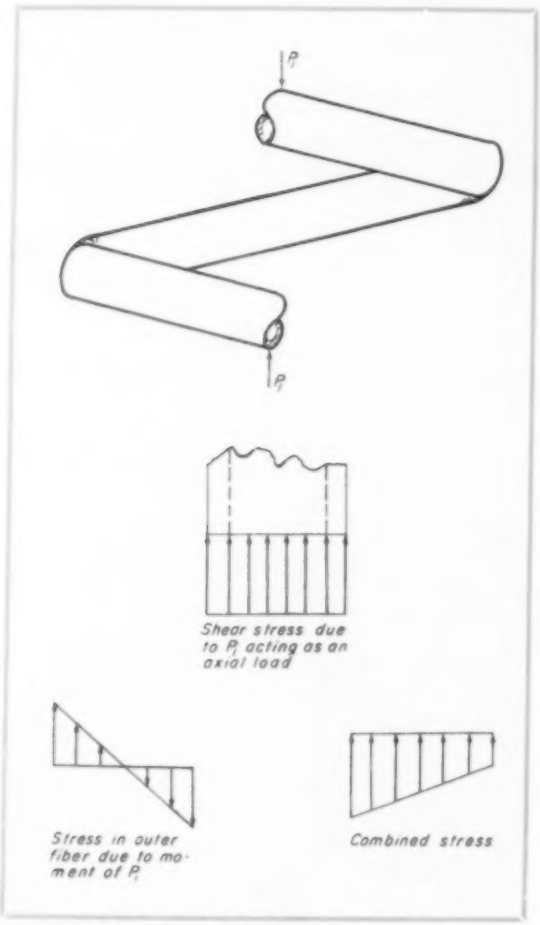

FIG. 2. STRESS IN A SINGLE TURN of coiled tube.

FATIGUE

When a section of tube is subjected to numerous cycles of repeated loading, it may fail, even though the major stress in any cycle is considerably below static strength of the tube material. This is termed fatigue failure. The tube fails from a minute crack which extends until the tube breaks. Tubing with very thin walls should be avoided even if the calculated stress is low, because it is too easily damaged in use.

Apparently, fatigue strength is much greater when the grain flow has the proper direction in relation

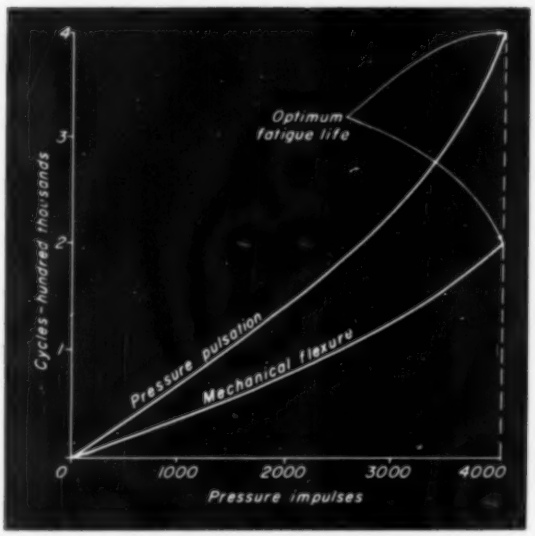

FIG. 3. FATIGUE LIFE REQUIREMENTS for 3,000-psi systems.

to stress. Nominal stresses cannot be used to determine fatigue life. Fatigue failure is usually caused by a *stress raiser* such as a burr, crack, pit, scratch, dent or handling mark.

Tubing requires careful handling to prevent nicking, scratching, and denting. A dent or imperfection affecting less than 20% of the tube diameter is not objectionable unless it is on the heel of a sharp radius. If a nick or scratch in aluminum alloy tubing penetrates less than 10% of the wall thickness, the tubing may be burnished with a fine-grade emery cloth and oil. It should then be finished and polished with crocus cloth and oil.

A typical fatigue failure occurs in a fine-grain structure, where it originates with coarser grain at an increasing radial distance from the center of the starting failure. Stress concentrations at critical points can often be alleviated by small grain structure and a smoother finish. Sharp edges should be avoided. Tube corners should be slightly rounded.

• **Predicting Fatigue Life**—At present not enough is known about tube failure to design for a precisely specified tube life, even in a simple torsional or coiled tube. Often, stress cycles required to produce failure cannot be predicted. The criterion for fatigue strength depends on the stress level and stress range

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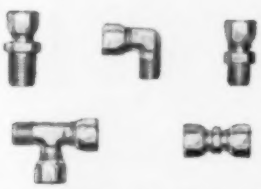

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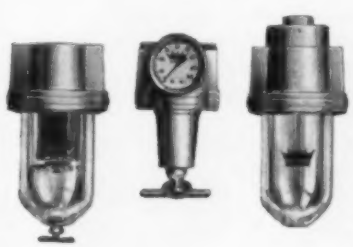

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It is hard to duplicate load cycles. They are often combinations of many different load cycles. Further complications are introduced by effects of: (1) magnitude of residual stress (2) surface condition of the tubing (3) plastic yielding (4) maximum dynamic stress (5) differential stresses.

It is possible to predict fatigue life within fairly close limits, and to obtain satisfactory resistance to fatigue action. Approximate fatigue life of hydraulic tubes may be determined from fatigue charts and conventional fatigue formulas.

SERVICE LIFE

According to aircraft specifications, fatigue life of tubing installations should be 400,000 cycles of pressure pulsations and 200,000 cycles of mechanical flex-

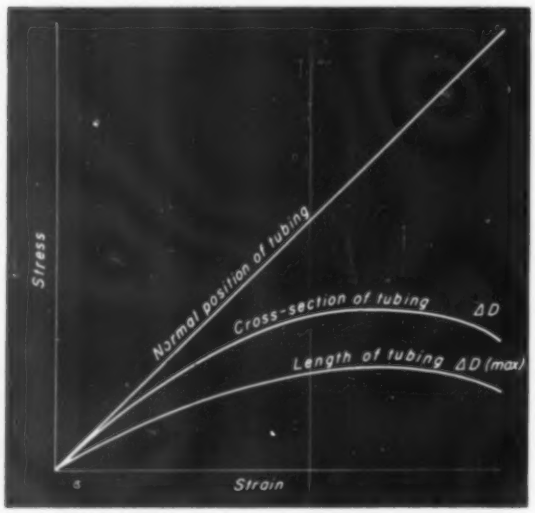

FIG. 4. **DEFLECTIONS** of hydraulic tubing.

ure combined in a rigid manner. Testing is at 4,500-psi impulses for use in 3,000-psi systems. The major factors in selecting tubing for long service life are:

a. Conditions of stress and vibration.
b. Allowable flexure and deformation.
c. Desired life of the hydraulic tubing.
d. Anticipated ambient temperature.
e. Operating pressure.

Service life determines the allowable stress for hydraulic lines at extreme temperatures.

DEFLECTION

In static stress analysis, cross-sectional area of the tubing and fatigue life determine strength. Critical bending will be induced in the tube, and excessive torsional and bending will be applied at the fitting if stresses are disregarded. Misalignment of the tube and the connecting fitting must be considered. If the tube and the fittings are parallel but misaligned by a fraction of an inch, the tube may be strained and deflected and the fitting assembled in a faulty connection.

Deflections of hydraulic tubing are primarily caused by fatigue failure as shown in Figure 4. Since stress is comparable to strain, if theoretical predicted values of deflections can accurately predict the strains (deflections) then they can also predict the stresses accurately). Exact measurement of deflection can only be obtained by testing.

Although the aluminum alloy tubings have a lower modulus of elasticity than steel, they have greater deformations and torsional twists at any given stress level. Limiting deflections for stainless steel tubing does not apply to comparable aluminum alloy tubing.

For tube members under axial tension or compression, the lengthening or shortening over a given length can be decreased only by increasing the area of the tube and thus reducing the stress. Tube deflection is caused by loads applied to the tube, vibration, or by long distances between clamps.

• **Installation Design**—Rigid tubing mounted on structural members that deflect is normally designed for load. Tubing assembled to heavy components such as actuators, accumulators, cylinders, and reservoirs are subjected to vibration. For low deflections and low pressures, it is feasible to use 61 St. aluminum or 52 S-O aluminum as an alternate at temperatures less than 300F.

One of the striking facts about rigid tube failures is their proximity to the supported fittings. Flexure is accompanied by excessive deflection when supporting clamps are inadequate. It is important to distribute clamps properly to cushion as well as distribute the bending effect over a greater distance.

VIBRATION

Every object has a natural affinity to vibrate. At the proper moment when the exciting force is applied with the same frequency, there is a pronounced increase in the amplitude of vibration. This phenomenon is known as resonance. The calculation of natural frequencies is significant in hydraulic tubing design since it is important to investigate the stresses imparted by vibration.

Vibration causes oil leakage at fittings and weakens tubing where stresses are a minimum. If the tubing vibrates at resonance, its natural frequency must be changed. Increasing wall thickness will increase the frequency, decrease vibration amplitude, and decrease induced bending stress.

After a series of tube tests to obtain frequency and amplitude pulse readings, vibration stresses which cause bending at the fittings should be considered. The tests will show which axis is under critical vibration. By installing supporting clamps or using stiffeners flexible enough to control natural frequencies, fitting stresses can be minimized.

Military specifications give clamp spacing to support tube against stresses and vibration. In vibration tests, various clamps may also dampen vibrations to

a degree. Nevertheless, a free flight is the only way to learn actual vibration effects.

• **Vibration Sources**—Tubing systems under free vibration will usually vibrate at one or more natural frequencies which are properties of the elastic system. This problem is intensified by sonic noise developing from jet engine exhaust. This causes high frequency structural vibration. To control natural frequency of the various tubing configurations, the frequency spectrum of the installation area should be known.

Engines have such a high vibration they shake the entire hydraulic system. The most severe effect is bending moments at the fittings. The resulting stresses are increased by reduced wall thickness or pits and imperfections which act as stress raisers.

In designing for vibration, remember that the maximum combination of stress factors used in ordinary static design tests rarely occurs in actual service and is not very important. The designer is usually interested only in the number of vibrations and the magnitude for normal operation.

The number of cycles for given load application should not be over estimated. Though some tubes quickly accumulate millions of cycles, many others vibrate much slower. If natural frequency should coincide with a repeated impulse frequency deflections can build up dangerously, and stresses can be far above those calculated for static loading. ▼▼▼

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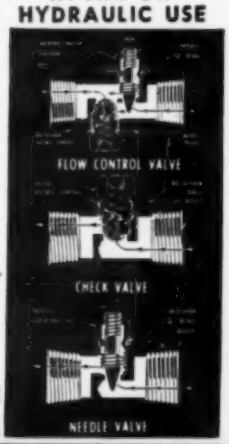

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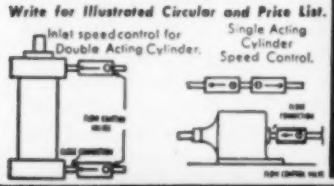

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1065	8.3	25	30	1	33
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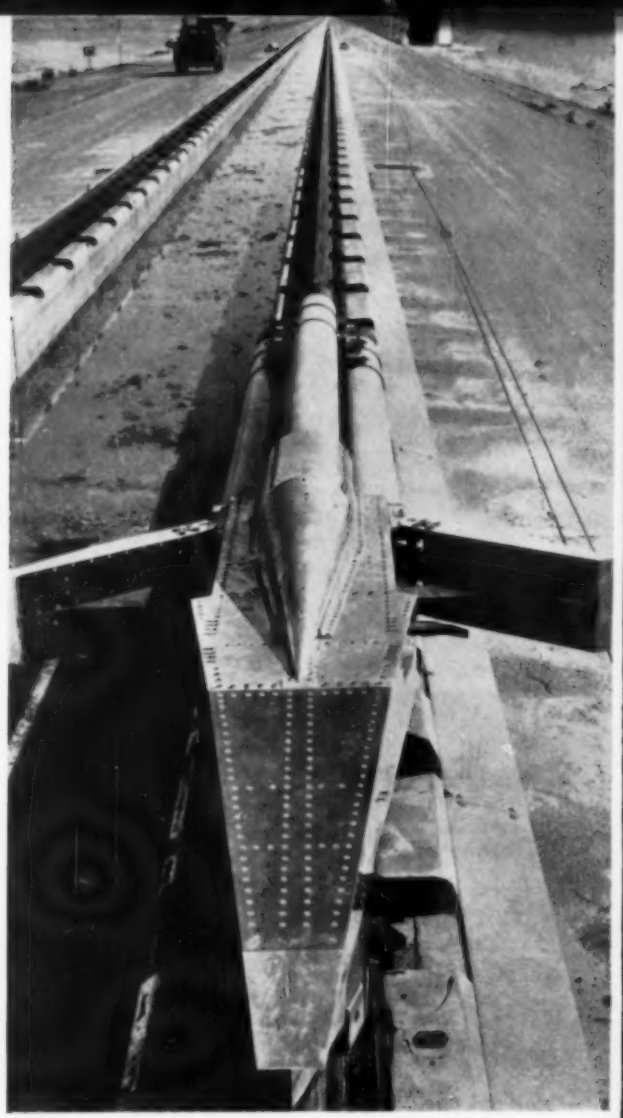
Braking a rocket sled

• By **FREDERICK D. HENRY,**
Engineer, Norair,
A Division of Northrop Corp.
Hawthorne, Calif.



THIS rocket sled is brought to a stop from 2700 mph by wind resistance created when braking fins swing out from its sides. A hydraulic snubber prevents the tremendous air blast from ripping the fins off the sled. The snubber consists of a hydraulic cylinder which meters oil out at a gradually decreasing rate as the cylinder retracts. The cylinder rod attaches to the fins through a linkage.

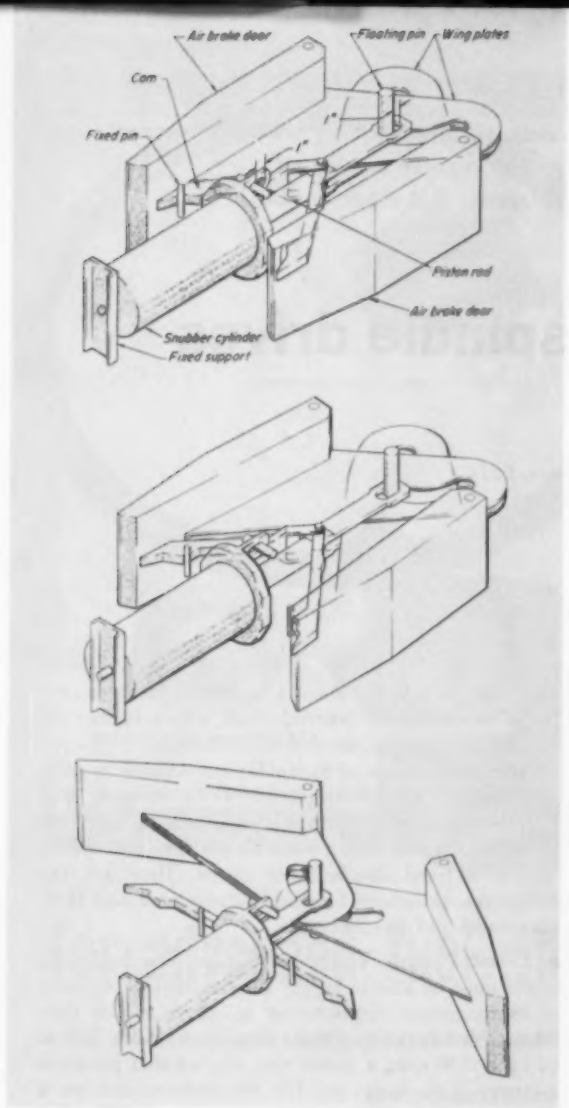
The sled tests missile and rocket inertial guidance components. It is 16 feet long and carries a 100-lb payload. Because it operates on a monorail, it can't use the conventional water braking system. On dual-rail sleds, scoops dig into a water channel between the rails to stop the sled.

• **Automatic Brake Application**—The fins, or air brake doors, are held closed during acceleration to prevent drag. They open at peak velocity for maximum braking. Peak velocity occurs when the rockets burn out, and inertia direction changes from acceleration to deceleration. At this point air drag is maximum.

The snubber cylinder weighs 50 lb and mounts so that it can move 1 inch fore and aft. During acceleration, inertia holds the cylinder assembly aft. The force from this inertia holds two wedge-shaped cams around pins, locking the doors closed. At 70g acceleration, holding force is 3500 lbs.

At rocket burnout, which occurs about 2 seconds after firing, air drag begins to decelerate the sled. Inertia force reverses, and the cylinder moves forward. The pins serve as a fulcrum about which the cams move and force the air brake doors open. High velocity air enters between the inner surface of the doors and the side of the sled. The snubber piston moves forward allowing gradual opening of the doors.

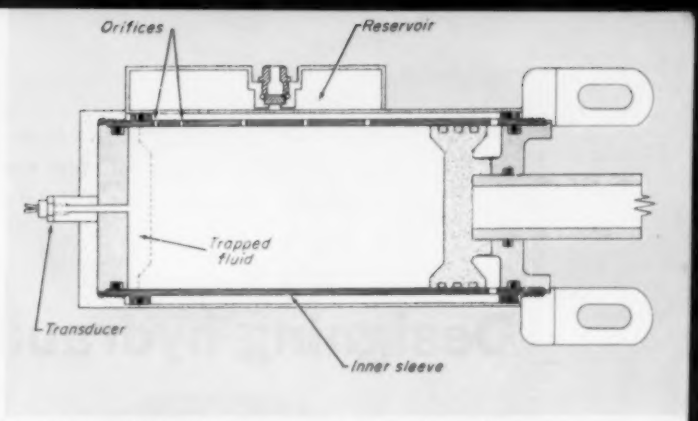
The air blast creates 176 psi on the doors. Total



force retracting the snubber resulting from air pressure on both doors is 80,000 lbs. The doors open in .3 sec. Without snubbing the doors would open in .004 sec.

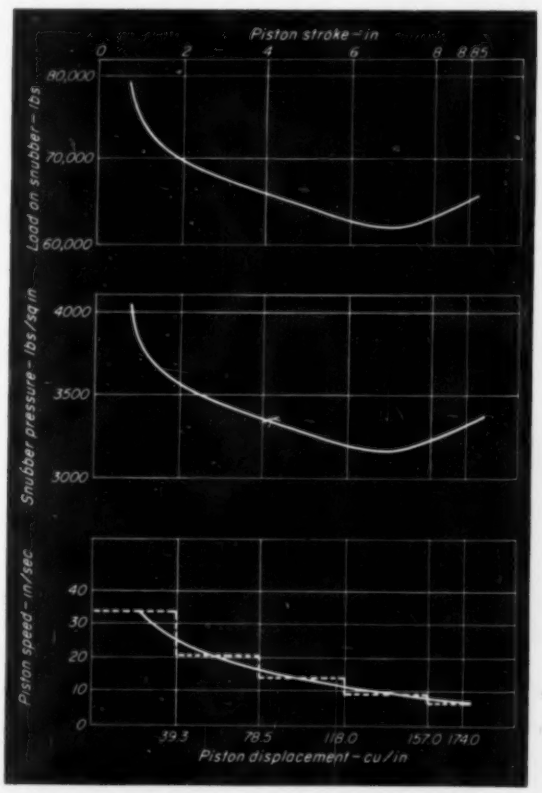
• **Orifices Control Piston Speed**—The snubber cylinder has an inner and an outer sleeve. Orifices in the inner sleeve permit fluid ahead of the piston to enter the cavity between the inner and outer sleeve and return at the rod end of the cylinder. As the piston retracts, it covers orifices, reducing the quantity of fluid bypassing the piston. This gradually decelerates the piston rod and door opening linkage. At the end of the stroke a small amount of fluid is trapped ahead of the piston to prevent its hitting the cylinder head.

The cylinder's outer shell connects to a reservoir which stores fluid displaced by the rod when the cylinder retracts. ▼▼▼



SNUBBER CYLINDER has orifices in the inner sleeve. These allow fluid to flow from the head end to the rod end of the cylinder. As the piston retracts from wind force on the air brake doors, it progressively covers orifices. This reduces the quantity of fluid bypassing the piston and gradually brings it to a stop. The last orifice closes before the end of the stroke. Fluid trapped ahead of the piston prevents shock at the end of the stroke. Three aluminum bronze piston rings prevent leakage past the piston. A transducer in the head end of the cylinder is wired to instruments which record snubber pressure during acceleration and deceleration.

SNUBBER LINKAGE AND CYLINDER are held aft during acceleration (top). Entire assembly moves forward one inch as rockets burn out and deceleration starts (center). This rotates the cams about the fixed pins and prys the doors open. The bottom view shows the airbrake doors wide open and the snubber fully retracted. The 8.8-inch stroke takes 0.3 sec.



FORCE ON SNUBBER is a maximum when the doors begin to open. It decreases until near the end of the stroke when most of the orifices are covered. Snubber pressure drops from 4000 psi at the start of the stroke to 3300 psi when fully retracted. The piston decelerates from 33 in./sec. at the start of the stroke, to 5 in./sec. at the end.

Hydraulic spindle drives have many advantages. Because they are more compact and pack more power into less space, they help improve machining accuracy. They can give infinitely variable speeds in a range of 400:1

Designing hydraulic spindle drives

• By **BEN WELTE**, *Technical Director, Colonial-Romulus Division Colonial Broach and Machine Co., Detroit, Michigan*

A HYDRAULIC drive is lighter than an equivalent electric drive because all the heavy components—electric motors, hydraulic pump, control valve, and reservoir—are mounted on the floor. The only component attached to the spindle is the hydraulic motor, which packs more horsepower per unit space, than any other means of power. For example, a 20-hp motor rated at 1800 rpm, weighs approximately 50 pounds. An equivalent electric motor weighs about 390 pounds.

10-HP SPINDLE DRIVE

The spindle on a contour milling machine designed by Colonial-Romulus Div. has a rating of 10 hp, and a speed range of 2200 rpm, infinitely variable down to 44 rpm. This is a speed ratio of 50:1. Three components contribute to the changes in speeds: a variable displacement hydraulic motor enables the operator to change spindle speeds from 2200 to 550 rpm giving a speed change ratio of about 4:1. The hydraulic motor drives two planetary transmissions, which further reduce spindle speed to the desired 50:1 ratio.

Two combinations of hydraulic components to drive the spindle were investigated: (1) a constant displacement hydraulic pump driving a variable displacement motor, and (2) a variable displacement pump driving a fixed displacement motor. Here are the design considerations for each arrangement and their advantages and disadvantages.

• **Fixed Pump, Variable Motor**—The hydraulic motor must be able to supply the required horsepower at its maximum displacement setting at which time the machine is running at its slowest speed. To deliver 10 hp at 550 rpm, a motor was selected that produces a torque of 61 lb.-in. per 100 psi pressure, and has a displacement of 3.82 cu. in. per revolution. The following calculations were then made:

$$\text{Torque, } T = \frac{\text{hp} \times 63025}{\text{RPM}}$$

$$T_{550} = \frac{10 \times 63025}{550} = 1150 \text{ lb.-in.}$$

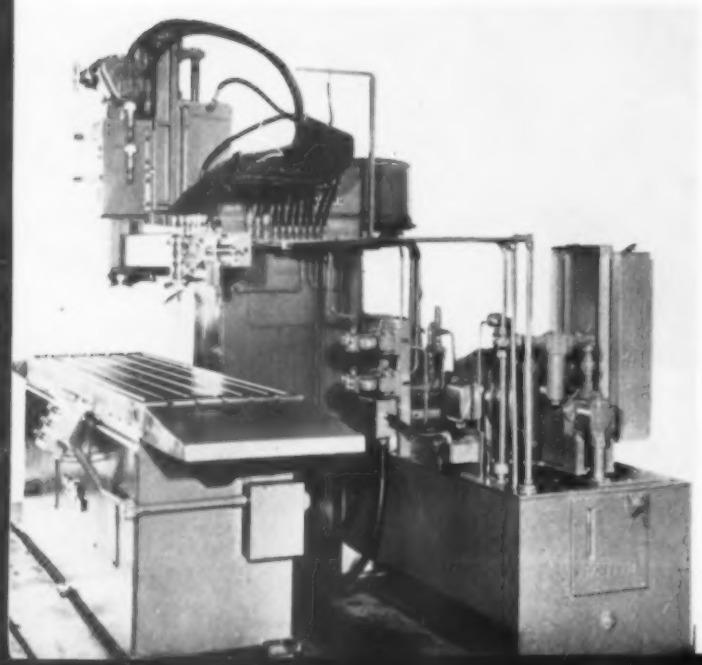
$$\text{Pressure, } P = \frac{\text{T Req'd} \times 100}{\text{T of motor}}$$

$$P_{550} = \frac{1150 \times 100}{61} = 1880 \text{ psi}$$

$$\text{Volume, } V = \frac{\text{Displ/rev} \times \text{rpm}}{231}$$

$$V_{550} = \frac{3.82 \times 550}{231} = 9.2 \text{ gpm}$$

Working pressure is well within the motor and pump rating of 2000 psi. It should be noted that all calcula-



HEAVY HYDRAULIC COMPONENTS of this contour milling machine are mounted on the floor, off the machine. Light variable displacement hydraulic motor drives handwheel controlled spindle.

Jet brake cup — LS-53
Synthetic lube diaphragm — LS-53
Diesel equipment seal — Viton
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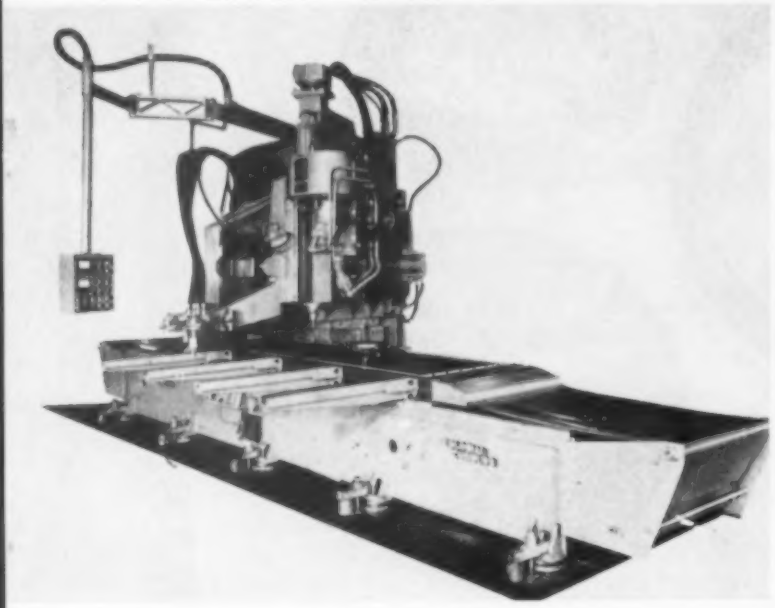

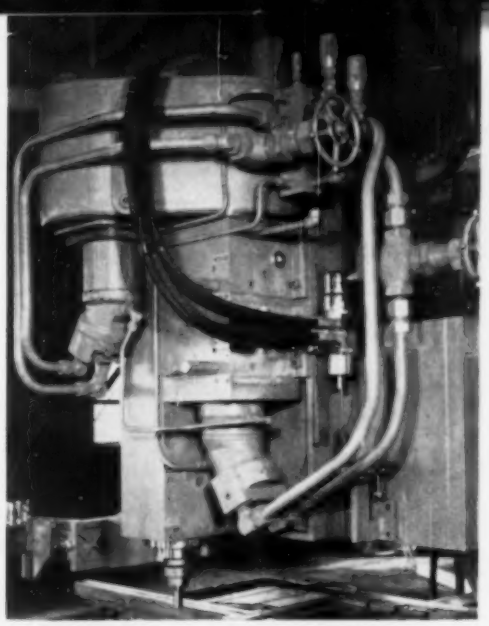

2-DIMENSIONAL PLANER CONTOUR MILL has 400:1 spindle speed range. Shown are low/medium-range speed hydraulic motor (upper-left), spindle housing, and high-range speed hydraulic motor (lower right).

tions shown are theoretical because they do not take into consideration various frictional losses and efficiencies.

Having selected a motor, the next step was to choose a hydraulic pump. Again, consider the system at its lowest speed, when the motor is set at its maximum displacement. From the above calculations, the pump must displace at least 9.2 gpm. It is, however, desirable to select a pump with a slightly larger capacity to compensate for small leakage losses within the pump, motor, and control valves. In this case, the pump selected was rated at 10.2 gpm at 2000 psi.

In this circuit, which requires a constant 10-hp output at all speeds, the variable displacement motor is mounted at the spindle and is driven by a fixed displacement pump. The same volume of oil is pumped at the same pressure regardless of motor speed. Thus, the pump will deliver the same amount of oil whether it drives the motor at 550 rpm or 2200 rpm. Any reduction in motor displacement will result in an increase in output speed, and a reduction in output torque. Since speed increases by the same proportion that torque decreases, output horsepower remains constant. When the motor is adjusted to its minimum displacement, it will reach top speed of 2200 rpm.

• **Variable Pump, Fixed Motor**—In the alternate arrangement, a variable displacement pump drives a fixed displacement motor, equal to the maximum displacement of the variable displacement motor previously described. The fluid supply in this arrangement is variable. This system, if feasible, would have a smaller, lighter motor mounted at the spindle. This size fixed displacement motor weighs about 50 lbs, compared to 150 lbs for the variable motor. This fixed displacement motor meets the same specifications of 9.2 gpm at 550 rpm, and 1880 psi for the required torque. At 2200 rpm, torque, pressure and volume for the fixed displacement motor would be:

$$T_{2200} = \frac{10 \times 63025}{2200} = 287 \text{ lb.-in.}$$

$$P_{2200} = \frac{287 \times 100}{61} = 470 \text{ psi}$$

$$V_{2200} = \frac{3.82 \times 2200}{231} = 36.8 \text{ gpm}$$

The fixed displacement motor requires the same amount of oil per revolution as the variable motor at its maximum displacement. To speed up the system, from its base speed of 550 rpm, it is necessary to pump more oil, (in this case four times as much as in the previous example) to reach the same high speed. This requires a variable displacement pump that is larger and more expensive than the one in the previous arrangement. In addition, larger lines, control valves, and oil reservoirs will also be required. Thus, under ordinary circumstances, it is more economical to install a variable motor at the spindle, driven by a fixed displacement pump.

20-HP SPINDLE DRIVE

To get a 400:1 speed range (6000 to 15 rpm) on a 20 hp planer type countour mill, the speed range was divided into three groups—low, medium, and high. The design was based on a standard 20-hp spindle with a speed range of 1600 to 31 rpm, obtained through a 4:1 hydraulic speed adjustment, and two planetary transmissions. Pick-off change gears were used to reach down to the low speed of 15 rpm. The high speed of 6000 rpm was obtained with a

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separate smaller displacement hi-speed hydraulic motor. This eliminated excessive gearing speeds.

This scheme shows the advantages of hydraulic drives.

The 20-hp hi-speed motor is 6¼ in. in diameter, and 15 in. long. This space could easily be spared on the spindle without making it too heavy or bulky. The spindle housing was designed as the central member. Clustered around it were the medium/low speed hydraulic motor, two reduction gear units, change gear case, and the high speed motor. To keep the overall dimensions of this complex spindle unit within limits, a variable displacement pump was selected to drive fixed displacement motors at the spindle.

• **Slow Speed Range** Torque, pressure, and volume for this arrangement were calculated for a minimum motor speed of 400 rpm. The motor selected has a torque of 95 in.-lb. per 100 psi, and displacement of 5.98 cu. in. per revolution.

$$T_{400} = \frac{20 \times 63025}{400} = 3150 \text{ lb.-in.}$$

$$T_{1600} = 787 \text{ lb.-in.}$$

$$P_{400} = \frac{3150 \times 100}{95} = 3300 \text{ psi}$$

$$P_{1600} = 825 \text{ psi}$$

$$V_{400} = \frac{5.98 \times 1600}{231} = 41.5 \text{ gpm}$$

HYDROSTATIC DRIVES FOR SPINDLES

Fixed and variable displacement pumps and rotary fluid motors, used as units, can be used in a variety of ways in hydrostatic transmissions for adjutable speed drives. They can be used individually. They can also be used in parallel combinations as:

(1) constant displacement units.

(2) constant displacement unit, in parallel with a variable displacement unit. The variable displacement unit operating from zero to maximum displacement on one side of center only to supplement output of the constant displacement unit.

(3) same as above, except the variable displacement unit crosses center to subtract from torque and increase output speed if units are motors, or subtract from delivery of constant displacement unit, if pumps.

These are some outstanding characteristics of axial parallel piston type rotary fluid motors, applied to spindle drives:

- **High efficiency and reliability**
- **Excellent low speed characteristics resulting from low internal frictional losses.**
- **Low inertia of rotating parts permits very rapid acceleration, deceleration, and reversal.**
- **They can be stalled indefinitely without damage, thereby, protecting spindle drive.**
- **Excellent horsepower versus weight ratio.**

L. G. JORDAN *Vickers Incorporated*

At first glance, the calculated pressure seems to exceed the design limits of the pump. It was, however, decided that this pressure was permissible because high pressure occurs only at the low end of the speed range of 400 rpm and it was unlikely that in actual practice the spindle would run at full horsepower at this particular speed for any length of time. The pump selected for this drive had a rated output of 45 gpm at 1150 rpm with supercharged intake. In this type circuit, the pressure line connects the pump to the motor. In addition, the motor discharge is brought directly back to the pump suction. A small displacement pump feeds oil into this suction line. As a result, the pump intake is kept at 100 to 150 psi at all times. This additional oil makes up for all internal leakage in this closed system.

Supercharging is an excellent way to obtain high efficiency from a hydraulic system. It is also the most economical way to obtain the desired results. The cost of a small supercharging pump is quite low. If the pump were not supercharged, it would only deliver 30 gpm (compared to 45 gpm) which would require a larger variable delivery pump, at higher cost.

Because of occasional high pressures, a thermostatically controlled, water-type, oil cooler was installed to remove heat caused by slip. Drain lines from the motors and pump were connected to the cooler.

• **High Speed Range**—A fixed displacement motor was selected for high spindle speeds. It was rated at 1900 rpm, displacing 3.82 cu. in. per revolution, and producing 61 lb.-in. of torque per 100 psi. To hold the change gear ratio within acceptable limits, this motor was run at 800 rpm to 2400 rpm. This is permissible since at high speed, system pressure is very low. Torque, pressure, and volume values at 800 and 2400 rpm were calculated.

$$T_{800} = \frac{20 \times 63025}{800} = 1580 \text{ lb.-in.}$$

$$T_{2400} = 526 \text{ lb.-in.}$$

$$P_{800} = \frac{1580 \times 100}{61} = 2600 \text{ psi}$$

$$P_{2400} = 866 \text{ psi}$$

$$V_{800} = \frac{3.82 \times 800}{231} = 13.3 \text{ gpm}$$

$$V_{2400} = 40 \text{ gpm}$$

The pump selected for the machine will deliver 45 gpm for the medium speed drive.

A small electric motor, mounted on the side of the pump increases and decreases pump displacement through pushbutton control. The motors were mounted to the transmission without flexible couplings to make a more compact assembly. To do this, the motor's outer shaft bearings were replaced with a loosely-fitting bronze guide ring. When the motor is mounted on the transmission, the bronze guide ring is ineffective, and the upper transmission bearing takes over for the bearing which was removed. ▼▼▼

Continued from page 61

switches, pressure switches and other electrical control elements are switched through relays to energize valve solenoids. These, in turn, sequence the hydraulic system.

Solenoids for valve operation usually provide less than 15 lb. force and are limited to about 35 to 40 lb. force. Spool valves in sizes to ¼-inch are usually actuated directly, but solenoids for direct operation of larger valves would be bulky. For valves above that size, a direct actuated, solenoid valve is combined with a pilot-operated valve. The solenoid valve controls only pilot flow to the larger valve. The combination, which mounts together, is called a solenoid-controlled, pilot-operated valve. A 2-position, solenoid-controlled valve may be combined with a 2-position, pilot-operated valve; or they may both be 3-position valves. Common combinations are shown in the diagram.

Valve solenoids may be either ac or dc. Because of high inrush current, a-c solenoids limit valve operating frequency. Fast cycling of a-c solenoid valves causes heating because average current is higher than for slow cycling. D-c solenoids have no inrush current and are not subject to heating because of fast cycling.

Recently developed, oil immersed solenoids have improved thermal and mechanical characteristics. They have longer life because of lower impact forces and reduced temperatures.

MOUNTING AND CONNECTIONS

Valves may have threaded ports in the valve body, flanged connections, or ports on a ground surface for subplate, panel, or manifold mounting. Some valve designs use all three methods of porting. Ports in the valve body have either dryseal pipe threads or straight threads. Flanges for welded or threaded pipe connections are bolted to the valve body and sealed with O-rings.

Valves having ports on a ground surface are called panel mounted valves. They are bolted to a subplate, panel, manifold, or machine member drilled to match the valve ports. O-rings seal each port. Panel or flange mounting simplifies maintenance because valves can be removed without disturbing line connections. This mounting also reduces the danger of distorting the valve body when pipe connections are tightened.

Panel mounted valves may also be mounted on a manifold to reduce piping connections and leakage. A manifold may be made from a drilled steel block, or be sandwich construction in which milled passages in the center plate are enclosed by end plates. The assembly is brazed together. ▼▼▼

Reasons why WILKERSON Pure-Flo FILTERS

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1 EXTRA CASTING, at no additional cost, houses the filter cartridge, enabling use of larger than usual cartridge. It also places the cartridge out of the filter bowl which makes the complete capacity of the bowl available for storage.

2 EXTRA LARGE CARTRIDGE results in less pressure drop as air has 17 sq. in. surface through which to travel. Rigid, impregnated felt cartridge (without premium cost) filters out particles as small as 5 microns, cartridge can be cleaned and reused indefinitely.

3 EXTRA LARGE STORAGE BOWL will hold more than half a pint of contaminants—does not need draining as often. Bowls are available in transparent plastic or Zamak metal.

The Wilkerson Pure-Flo Filters are available in ¼" through 5" N. P. T. for 16 to 3100 cfm at 100 psi.

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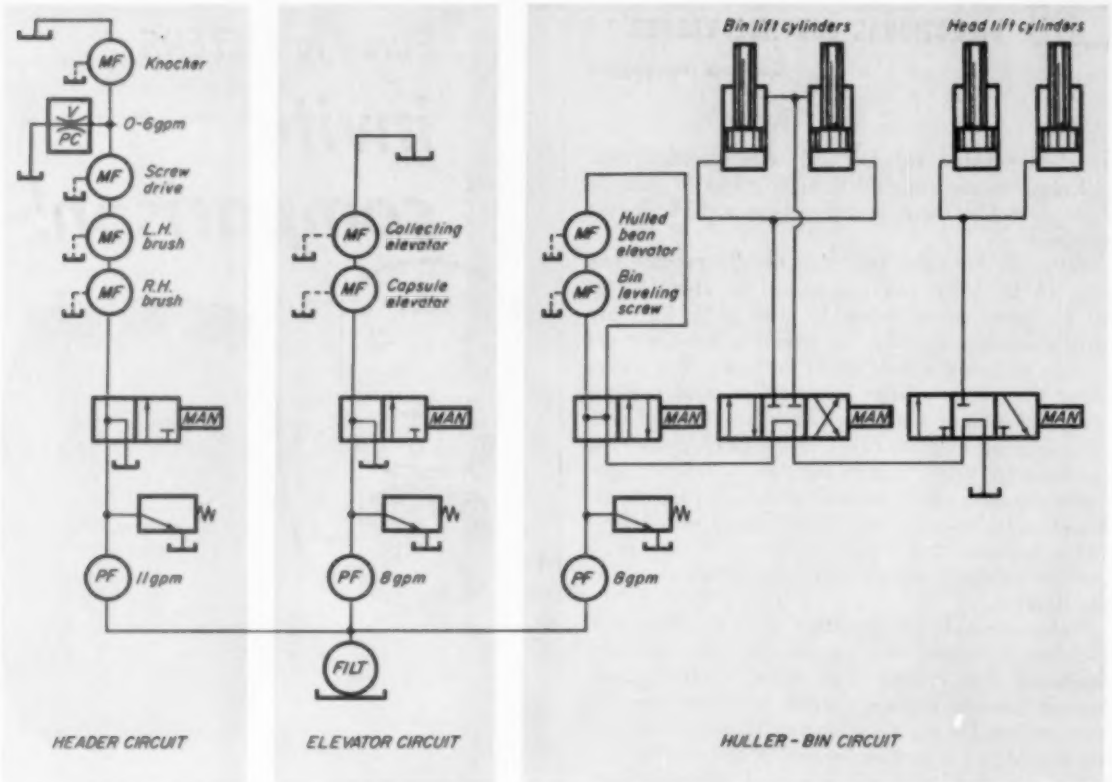


FLUID MOTORS which power operations in this castor bean harvester are series-connected in groups of 2 and 4 to keep them running at the same speed. This avoids synchronizing problems but requires a design to limit pressure. In a series circuit, pressure at the pump is the sum of pressures at each motor (all motors equal size). To keep pump pressure under the 1000 psi rating of the vane pump which we intended to use, we divided the system into three circuits, each with its own pump.

An 11-gpm pump supplies the header circuit which has four series-connected motors. Speeds of the first three are identical. Speed of the fourth is regulated with a pressure compensated flow control valve which bleeds off 0-6 gpm from the knocker motor.

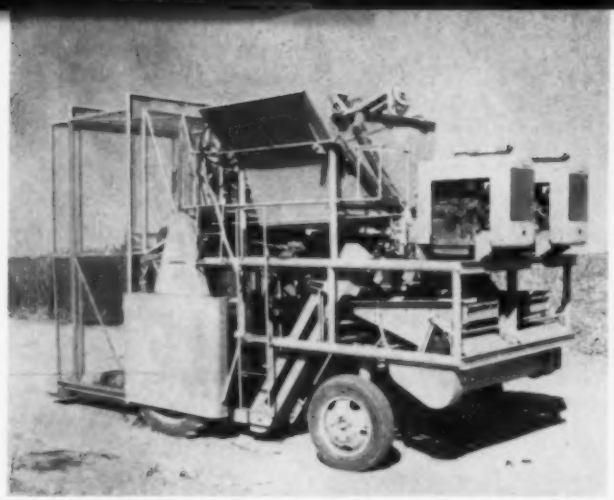
The elevator circuit, supplied by an 8-gpm pump, has two, series-connected motors.

In the huller circuit, powered by an 8-gpm pump, two series-connected motors convey beans into the huller and storage bin. This pump also supplies two bin-lifting cylinders and two head-lifting cylinders.

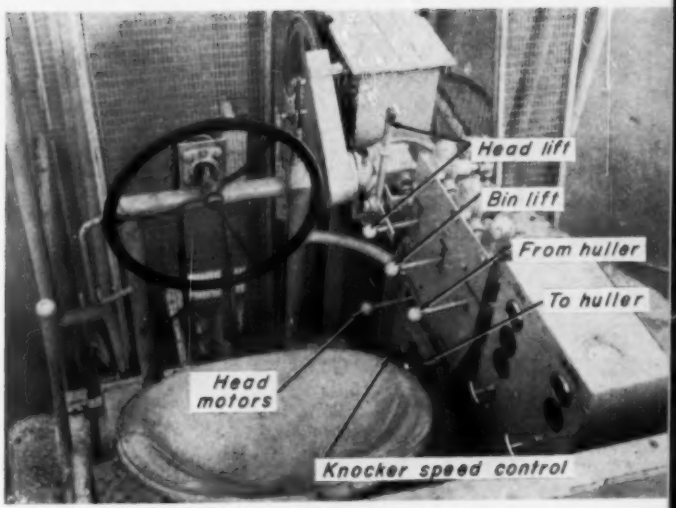
The three circuits operate independently of one another but share the same reservoir, filter and drain lines.

Harvester's three pumps power separate circuits

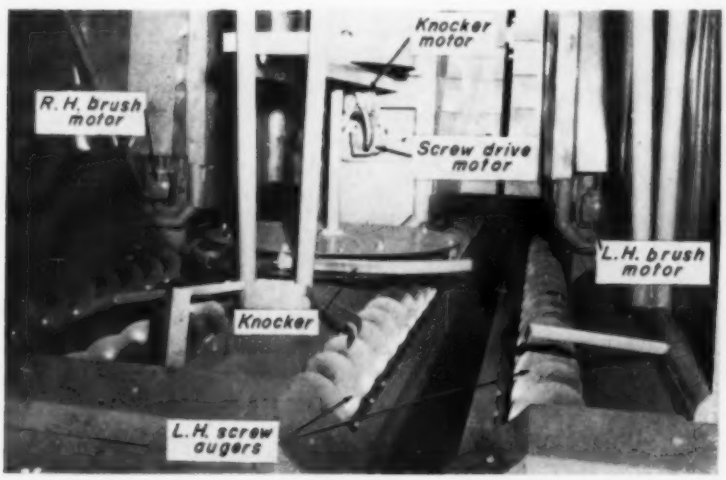
• By **DON SUVERKROP**, *Mechanical Engineer, Hopper Machine Works, Inc., Bakersfield, Calif.*



CASTOR BEAN HARVESTER is powered by two gasoline engines. One propels the machine and the other drives three hydraulic vane pumps to power the harvster's three hydraulic circuits.



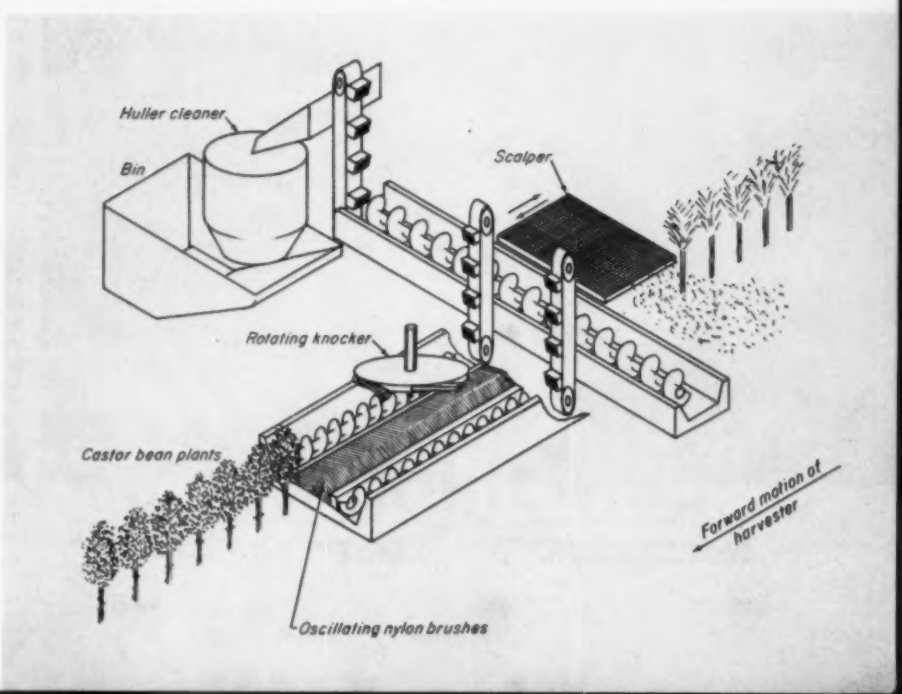
HYDRAULIC CONTROLS actuate the harvester. Five panel-mounted control valves direct the oil flow to each function of the harvesting operation. They are equipped with non-adjustable relief valves set at 1000 psi. Relief springs are available for pressure settings of 850 and 1250 psi.



CASTER BEAN'S VIEW OF HARVESTER header section which admits plants and strips bean capsules off stalks. The four series-connected fluid motors power the reciprocating brushes, augers and knocker.

WHEN CASTOR BEAN PLANTS enter the harvester, the stalks move between reciprocating nylon brushes which form a horizontal seal. A rotating knocker hits the stalks dropping bean capsules off the plants. The stalks pass on through the rear of the machine, while screw augers convey the capsules, together with leaves and other impurities, to elevators which lift the material to the scalpers.

Reciprocating screens in the scalpers separate the bean capsules from branches and leaves, and drop them into a transverse auger which channels them to the huller-cleaner. The trash is discharged. The huller has two horizontal, rubber-faced discs which rotate and crack the capsules. The hulls are removed by suction and discharged to the atmosphere. The beans drop out of the cleaning chamber into a cup-elevator, and move on to the collecting bin. Two double acting cylinders tip the 1-ton bin to empty it into a truck.



NEW NORGREN TRANSPARENT BOWL WITHSTANDS RIPPING IMPACT OF HOLLOW NOSE BULLET

Norgren "Safety-Green" bowl doesn't shatter... yet is fully transparent

Heavy steel bar dropped endwise from 12 ft. height merely scuffed surface of bowl carrying over 200 psi internal pressure.

Bowls for compressed-air-line filters and lubricators should be transparent to permit quick visual inspection. However, in the past, unusual or special applications often required the use of bowl guards or wire reinforcements... sacrificing the advantage of transparency.

Now... from Norgren... you get a fully transparent, yet super-tough, impact-resistant bowl that won't shatter, craze or break—designed for even the most severe service. As these photos dramatically portray, the new Norgren bowls are completely transparent and are able to withstand conditions far more exacting than ever encountered in ordinary use. Non-shattering, unbreakable bowls mean reduced replacement cost, less air-tool and equipment down-time, savings in maintenance and operating costs, greater employee safety.

These new green shatterproof bowls are now available for most Norgren air-line filters and lubricators—or may be obtained separately for replacement purposes from your local Norgren representative or distributor. Or, write for full information.

As a further test of toughness, the new Norgren bowl was placed in a heavy machine shop vise...

then compressed almost flat. Even in this extreme position, the bowl did not break or even crack.

Turned and squeezed again back to its original shape, the bowl still showed no cracking. Except for vise marks almost good as new!

...WITH NO SHATTERING!

Unretouched high-speed photo by University of Denver Research Dept. shows new Norgren Safety-Green Bowl a split second after penetration by bullet. Initial pressure of 265 psi is being relieved through bullet hole.

Specify Norgren "Safety-Green" Bowls

Large photo shows bowl after test. Only damage to bowl is clean bullet hole with no cracking, crazing or shattering. Impact has broken gauge. This test clearly demonstrates extreme toughness of Norgren Safety-Green bowls.

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P-2

AEROSPACE SECTION

Fluid Systems For Flight and Ground Support

F-27 Converted To Hydraulic Nose-Wheel Steering

Fairchild's F-27, the first all pneumatic powered civil aircraft in the U. S., now incorporates hydraulic power for its nose-wheel steering. Fairchild now includes a motor-pump package manufactured by Kellogg Division of American Brake Shoe Co. The package consists of a 28-vdc motor and a single stage, variable volume pump which delivers 5 gpm at 3000 psi and 12,000 rpm. Total package weight is about 14.5 lb.

New Vernier Cylinders For Atlas

A contract for redesigned pitch and yaw vernier cylinders which actuate the vernier guidance engines on the Atlas, has been awarded by Convair Astronautics Division to the Bohanan Manufacturing Co., Compton, Calif. Weight of the cylinders has been substantially reduced by the new Bohanan design. The contract includes engineering, development, qualification, and production of the vernier cylinders.

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Hydrostatic Testing To 10,000 PSI

A tester developed by Tri-Tech, Burbank, Calif. for Rocketdyne Div. of North American Aviation applies water pressure to 10,000 psi. The component is tested inside a cabinet and viewed through two safety glass panels, one at the top and one at the bottom of the instrument panel. Interior baffles provide a safety barrier for the viewing windows. Two mirrors in the cabinet enable the operator to view the reflected image of the test part without being in a direct line of sight. High intensity lights illuminate a rotating table operated by a handwheel which permits the operator to rotate the test part for examination during test.

Pneumatic Tester Produces 3000-g Shock

A pneumatic powered shock tester for small electronic components has been announced by Avco Research and Development Division, Wilmington, Mass. The new production tester is a departure from customary free-fall shock machines because it uses pneumatic actuation and control of the shock pulses. The tester handles up to 30-lb specimens and produces an impact velocity up to 192 in./sec. This includes the 3000-g, 0.2-millisec shock pulse required by MIL-S-19500B. The tester is 46 in. high. With a drop height of 7 in. at 80 psi, the machine develops a velocity of 192 in./sec, equivalent to a 4-ft, free fall drop.

For more news about fluid systems see page 92

Trends in secondary power systems

• By **CHARLES H. CANNON,** *Manager, Mechanical Systems Engineering*
Lockheed Aircraft Corp., Marietta, Ga.

WHAT type secondary power systems will be needed for future missile and manned space craft? This question is being asked by component manufacturers. Equipment designers are working hard to give them an answer. Their answers have some *if's* and *but's*, since secondary power system will depend largely on other subsystems like propulsion, electrical, and environmental control.

Hydraulic systems will be used for high power outputs, and compressed or hot gas systems for lower power levels. On small missiles, with very small control surfaces and low inertias, an electrical flight control system will probably be used. An electrical system is too heavy for larger missiles.

• **Hydraulic Pump Drive**—If an accessory pad is available, a hydraulic pump can be mounted on the pad and driven from a power take-off. If there is no accessory pad, an electric motor can drive the pump. A battery will furnish electrical power for the motor. This system is reliable and accurate but somewhat heavy because of battery weight.

Extensive research is being conducted to find a lighter system to convert various types of energy to hydraulic power. One approach is to use a turbine drive for a hydraulic pump with gas generator or a charged gas reservoir driving the turbine. Another method is a direct gas-to-hydraulic converter. This system uses a gas booster to intensify hydraulic pressure, Figure 1.

In some applications it is practical to use the energy from a flywheel to drive a hydraulic pump. The fly-

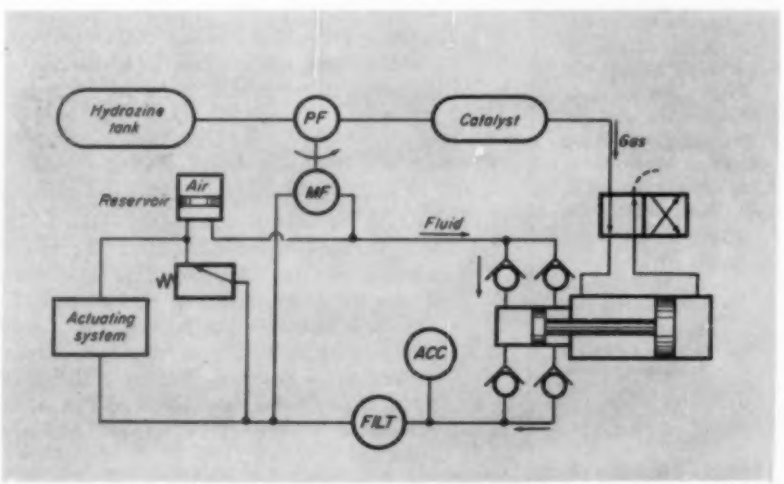

FIG. 1. GAS-TO-HYDRAULIC CONVERTER uses gas pressure acting on a large area to build up hydraulic pressure. This method is lighter and more reliable than using a turbine powered by gas driving a hydraulic pump.

wheel is brought up to rotational speed by external power from a ground service vehicle. Considerable energy can be stored for short durations.

Figure 2 shows the steps in converting prime energy into useful work. Eliminating any of the converters will increase efficiency and reduce weight.

• **Pressurized Gas Systems**—On small missiles where inertia of the control surfaces is low, a gas system may be used. The pneumatic or gas system has the disadvantage of low bulk modulus which restricts its use to actuators with low spring rates. The gas can be generated aboard the missile or stored in a gas reservoir. Stored gas systems will be effective for short duration power requirements.

Gas generators are now being used with both liquid and solid propellants. The solid propellant type is simpler but limited to short durations. Long burning times cause overheating. Throttling and on-off operations are also difficult with solid propellants. Nitroglycerin, diethyleneglycol dinitrate, and nitrocellulose are the most common solid propellants.

Liquid propellants are good for greater durations and are easier to control, but are generally heavier. The two most promising liquid monopropellants are hydrazine and ethylene oxide.

Figure 3 gives a weight comparison of 5-hp systems for time durations up to 100 min.

• **Space Craft Guidance**—Many guidance functions on space craft will not require high horsepower for operation and will probably be handled with electrical servo systems. Batteries, solar generators, or nuclear sources can supply the electrical energy.

On manned space craft, re-entry and landing will require high horsepower to actuate controls, drag devices, and landing functions. Hydraulic systems will be required for these functions. If the system is installed in the aerodynamic surfaces, it will be subject to temperatures as high as 2000 F. If a high temperature system is not developed, the pump, valves, and actuators will be mounted in the main body of the vehicle and cooled. Power will be transmitted by pushrods or other mechanical means to the surface. Since landing is one-shot operation, propellants may offer a weight advantage for landing or drag devices.

Figure 4 shows a pneumatic system, using a gas generator for power, driving screw-jacks through a turbine. The screwjack actuators give this system good output stiffness.

• **Leakage**—An important concern of the designer using hydraulics in space vehicles is overcoming system leakage for long flights. The primary requirement for a space craft hydraulic system will be one that can remain idle hundreds of hours and be leakproof and reliable when required to operate. Lockheed has developed a hermetically sealed hydraulic system for this application.

Missile systems must have long storage life so that they can be inactive for periods up to five years and be ready to operate without service. ▼▼▼

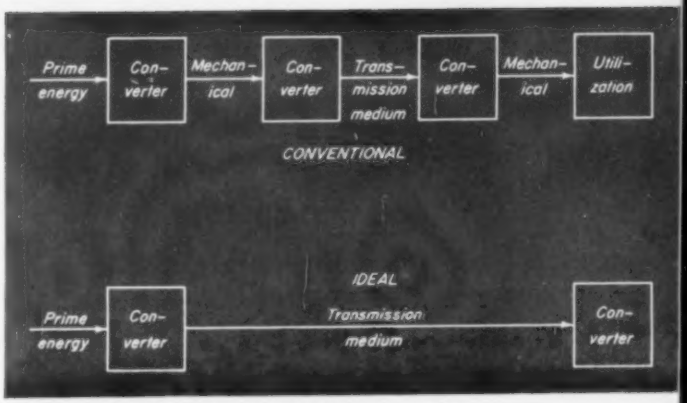

FIG. 2. CONVERTING PRIME ENERGY into usable energy for auxiliary power requires three energy converters (top). An ideal system, (bottom), would require only one converter. It would be lighter and more reliable.

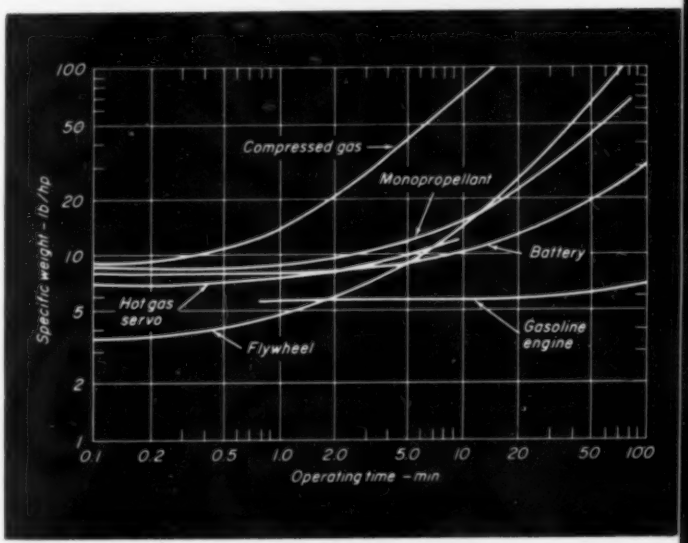

FIG. 3. WEIGHT COMPARISON of 5-hp systems for operating times to 100 min. In most systems the weight per hp increases rapidly with time duration.

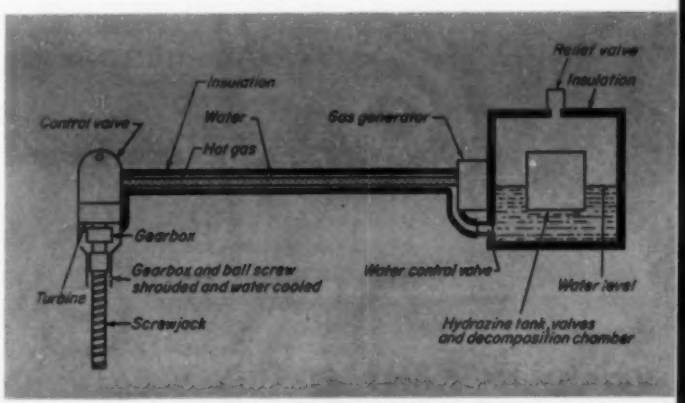

FIG. 4. HOT GAS ACTUATOR SYSTEM is stiffened by using screwjacks driven by a turbine. Gas lines are water cooled to reduce the operating temperature of the control valve and turbine.

ENGINEERED PRODUCTS

for Hydraulic, Pneumatic Service

Garlock "U" Cup and "V" Ring Packings (top) provide tight sealing, help increase efficiency of famous Tomkins-Johnson "Spacemaker" cylinders. Garlock molded cups (bottom left) and CHEVRON* Packings are also specified for air and hydraulic cylinders.

Tomkins-Johnson standardizes on Garlock "U" Cup and "V" Ring Packings for their famous "Spacemaker" air and hydraulic cylinders.

On a wide variety of "Spacemaker" applications, Garlock packings provide leak-proof service against air, water, and hydraulic fluids at temperatures to 250°F, pressures to 1000 p.s.i. Tomkins-Johnson specifies Garlock products because of their greater flexibility, minimum friction, and resistance to sudden shock loads.

Garlock "U" Cup Packings are specially designed for proper fit against the cylinder wall—this prolongs service life to a maximum. Available in several materials and designed to JIC standards, the cups are applied on diameters ranging from 1″ through 14″. Flexible and resilient Garlock "V" Ring Packings respond quickly to low gland and fluid pressures, offer positive, low friction sealing at all pressures. Available in various materials and sizes.

Enjoy the same advantages that Tomkins-Johnson does—standardize on Garlock hydraulic-pneumatic packings. Garlock's complete line also includes widely-used CHEVRON* Packings with an exclusive hinge-like construction that "rides" with the pressure . . . tightens as pressures increase, eases off as they decline . . . results in positive sealing with little friction. Garlock Molded Cups provide maximum efficiency in sealing air and hydraulic cylinders over a wide range of service conditions.

For more information, call your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalogs AD-163 ("U" Cup Packings) and AD-115 (CHEVRON Packings). Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

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GARLOCK

Circle **37** on Reader-Service Card

Designing a seal for the DC-8

• By **C. W. GALLOWAY**, *Research Engineer, Hydro Mechanical Group Testing Division, Douglas Aircraft Company, Inc., Santa Monica, Calif.*

TEFLON SLIPPER SEAL with square rubber loading ring has excellent abrasion resistance in applications with high frequency, low amplitude motions. The larger seal has been cycled 2,400,000 times, the smaller 1,625,000 times with no evidence of wear. ID (rod) seals require an inverted Teflon slipper. The square, rubber load rings can be used interchangeably for piston and rod seals.

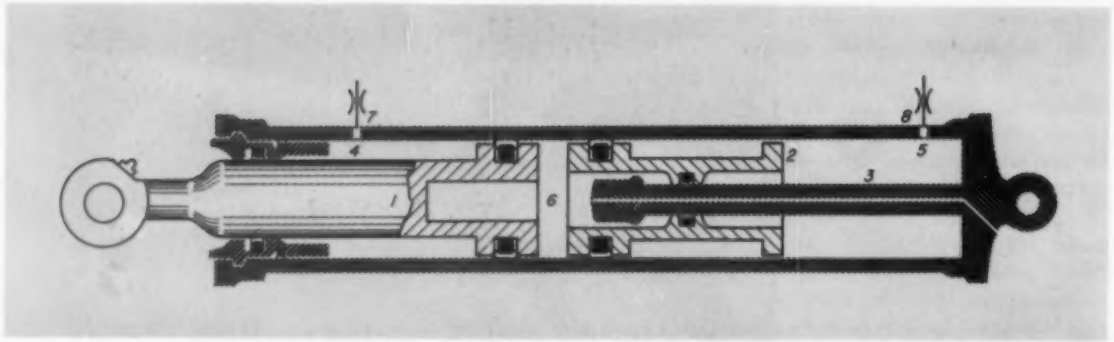
EXCESSIVE hydraulic fluid leakage in the bogie trim cylinders showed up early in the DC-8 tests. The leakage was traced to extreme abrasion of the high modulus, butyl O-rings developed for phosphate ester fluid. A mismatch of cylinder motions and O-ring physical properties probably caused the abrasion.

The dynamic seals are subjected to severe operating conditions. Kinematics ranged from long, high velocity strokes upon impact, to high frequency, low amplitude oscillations during takeoff and landing roll. Most of the time, damping oscillation frequencies are about 15 cps at a peak-to-peak amplitude of 0.35 in.

To obtain a leak free seal, Douglas tested various seal and backup configurations, O-ring compounds, lubricants, and surface finishes.

Various cross sectional configurations of both seals and backups were tried, but seal abrasion remained the same as with standard AN 6227 O-rings and MS-28782 backups. Tests showed that abrasion resistance varied directly with elongation. O-ring abrasion could be reduced significantly, though not sufficiently, by compounding for high elongation.

Lubricating the atmospheric pressure side of the O-rings with either the working fluid or a compatible grease did not improve O-ring abrasion sufficiently. The atmospheric side of the O-rings was lubricated by putting fluid



BOGIE TRIM CYLINDER is a hydraulic damper cylinder for the DC-8's bogie gear. It operates as follows: To move the bogie gear into trimmed position for either touchdown or retraction into the wheel well, 3000-psi fluid pressure is applied to chambers 4 and 5. Because of the difference in diameters of rods 1 and 3, piston 1 is held against piston 2 which extends until it is stopped mechanically at the end of rod 3. The bogie gear is now trimmed.

Upon touchdown, piston 1 retracts, forcing piston 2 in the same direction. Pressure in chamber 5 surges to high values due to the impact loading and the restriction orifice. With all four wheels on the ground, the pistons reciprocate together as a result of ground irregularities. This motion is damped because of the restriction orifices. Any internal leakage is ported to atmosphere from chamber 6.

in the cylinder volume which is normally empty.

Varying surface finishes from 4 to 32 microinch r.m.s. made little difference in O-ring abrasion, although smoother surface finish gave generally better results.

It became apparent that a new seal would have to be developed for the bogie trim cylinder. Since all failures resulted from excessive abrasion, it appeared that we needed a seal insensitive to friction, because O-ring abrasion is generally attributed to friction. Because of its low coefficient of friction, Teflon was proposed as the material to use.

• **Prestressed Teflon**—Teflon does not obey Hook's law (strain within an elastic body is proportional to applied stress) over the stress range required. So we provided auxilliary stress to achieve low pressure, low temperature fluid sealing. The most logical Teflon configuration appeared to be a sleeve, since stress is easily applied to a sleeve.

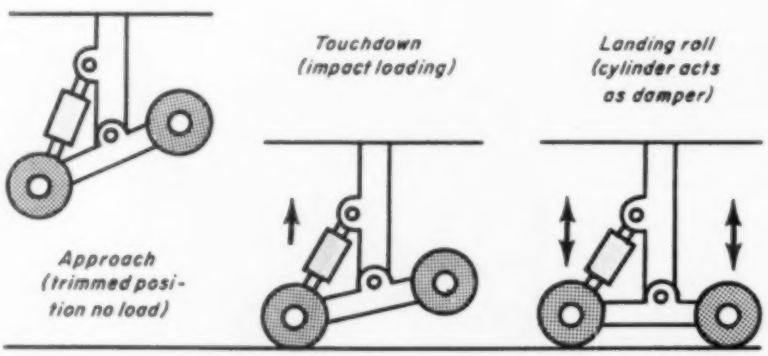
Considerable industry development work on hydraulic Teflon sleeve seals had given good abrasion resistance in stringent applications. The two big drawbacks of Teflon sleeves were difficult installation and leak-free sealing, even with loading devices. Various materials and configurations, such as rubber O-rings, metallic marcel and coil springs have been evaluated by industry for use as Teflon seal loading devices.

Various commercial Teflon seals were evaluated for the DC-8. All gave the same result—excessive leakage and difficult installation. However, it appeared a low temperature, low pressure, hydraulic seal could be developed with a Teflon sleeve, provided uniform stress could be applied. The standard O-ring, while unsatisfactory, was the best loading device.

• **Square Loading Ring**—It appeared that leakage past the Teflon slipper, when using a loading O-ring was caused by rolling and subsequent fluid pumping across the Teflon sealing surface. Perhaps a square cross-section rubber ring would prevent rolling and also provide uniform loading at the Teflon edges. A square,

TRIM CYLINDER BACKGROUND—

To prevent wheel bounce in the new DC-8 jetliner, Douglas uses hydraulic damper cylinders, called bogie trim cylinders, in the landing gear. The cylinders also align the bogie gear during retraction.



LANDING GEAR CLOSE-UP shows bogie trim cylinder in retracted position.

rubber loading ring was the solution. It produced a low leakage, Teflon slipper seal.

The seal configuration was established after testing various shapes and thicknesses of Teflon together with square cross-section rubber load rings. The seal can be used in standard MIL-P-5514 glands. This proprietary Teflon-elastomeric combination seal was laboratory tested in the bogie trim cylinder under simulated service conditions.

The seal has excellent leakage and life characteristics. In this application it gives 90 times longer life than AN 6227 configuration O-rings, at temperatures from —65 to 150 F and pressures to 3000 psi. DC-8 flight tests and service experience confirmed the suitability of the seal. ▼▼▼

INSTALLATION TOOL developed by Douglas engineers allows easy, distortion free installation of the Teflon slipper seal.

SEALOL

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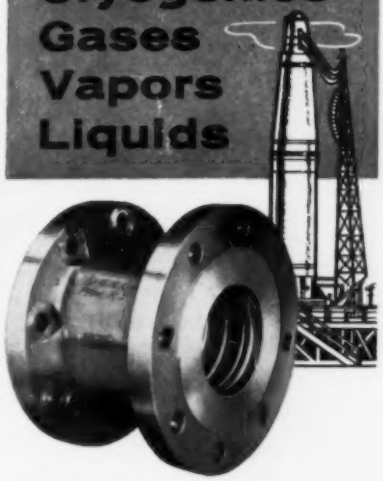

New soft-seat design insures leak proof action over a broad pressure range

Low pressure (1 pound or less) seats the poppet on a resilient disc inset in the body. As pressure increases, the resilient disc is radially displaced and a metal to metal seat results.

Specifications — sizes from ¼" to 6" and larger. Materials are steel, stainless steel, aluminum, brass or as required. Pressures to 6,000 psi. Temperatures from —425°F to +400°F. Available with pipe or tube fittings or flange ends as required.

Fully qualified — all models meet or exceed MIL-V-5524A. Sealol Check Valves are used aboard newest atomic subs, in rocket fuel-mixing plants, launching equipment and numerous industrial applications.

Applications — current uses include the Polaris launching system and the Atlas fuel handling system. Also at the Liquid Rocket Plant of the Aerojet-General Corporation, the Titan fuel handling and mixing systems.

Send for Bulletin HP02 or call S. J. Biello at STuart 1-4700 (area code 401) for detail information.

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Circle **53** on Reader-Service Card

AEROSPACE NEWS

from the fluid power field

Hydraulic Research appoints vice president

Edward R. Davis, active in the west coast aircraft and missile industry for the last 10 years, has been named vice president, director of marketing and contract at Hydraulic Research and Manufacturing Co., Burbank, a Bell Aerospace subsidiary. He was formerly west coast marketing manager for Chance Vought Aircraft and western manager of Avien, Inc.

Ryan

Davis

United Aircraft Products expands western operations

Frank A. Ryan has been named vice president and general manager, western operations, United Aircraft Products, Inc., Dayton, Ohio. He has been with United since 1952, and was formerly vice president, sales. Plans for the Gardena, California facility include enlarging the engineering and sales departments, additional metal fabricating equipment, regional prototype development, and short-to-medium production runs.

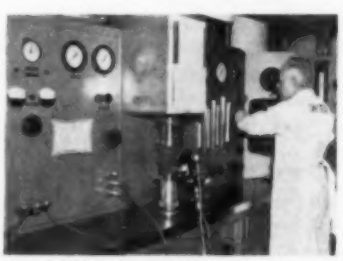
Testing jetliner's pneumatic valves

A pneumatic valve test stand at United Air Line's maintenance base near San Francisco International Airport tests low pressure valves for leakage, air flow, and maximum-minimum operating pressure. The stand efficiently tests ¼" to 6" valves on all jet's in United's fleet. On the DC-8, for example, the stand tests 23 of 37 valves.

During test stand operation, compressed air flows through a vertical coupling. The correct valve adapter is selected and centered on the coupling with the valve being tested. The parts are held by a torque motor driven screw jack clamping system, which is foot controlled. This leaves the mechanic's hands free to center parts and operate controls.

Paul-Munroe Hydraulics engineers, who designed and manufactured the stand to United's specifications, included a fail-safe feature in the circuit. A pressure switch prevents the clamp from opening while under pressure.

Once the valve has been properly secured, it is tested for air flow and leakage with 0.002 to 60 lb/min of air at pressures to 100 psi and temperatures from 40 to 120 F. The static pressure range is 5 in. H_2O to 150 psi. Flow can



Pneumatic valve test stand

be measured *into* the part for determining valve-plus-case leakage, or *out* of the part for valve leakage only.

Chance Vought name change

Chance Vought's shareholders recently approved a new corporate name, Chance Vought Corporation.

The word "aircraft" was dropped to reflect the company's diversity more accurately. In addition to the field of aircraft and its related activities, CV functions in such fields as electronics, astronautics, and missile range systems.

Bendix-Pacific appoints general manager

David H. Brown has been named general manager of the Bendix-Pacific division of The Bendix Corporation. He has been assistant general manager since 1955. Brown started with Bendix-Pacific in 1938 as a draftsman, just after graduation from Curtis-Wright Technical Institute with a degree in aeronautical engineering.

Koehler Aircraft promotes two

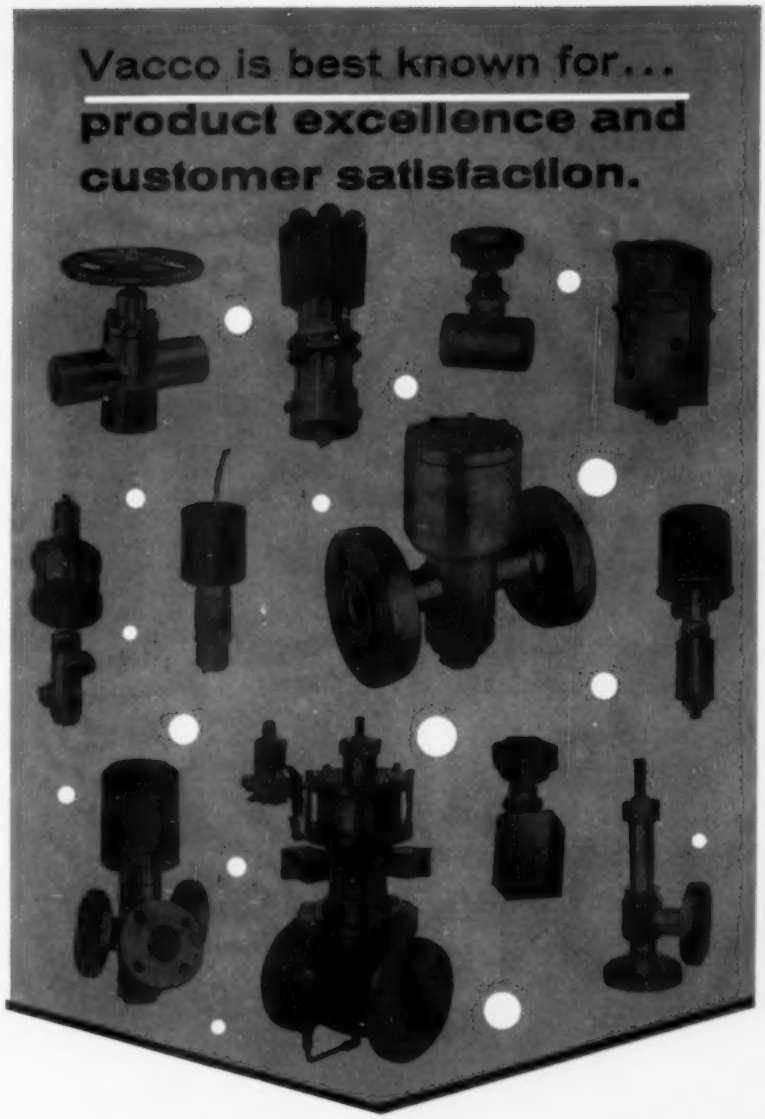
Raymond LaFontaine has been appointed chief engineer for advanced products of Koehler Aircraft Products Co., Dayton, Ohio. He had served as staff engineer of the company's west coast operations. His new post will be concerned with research and development of valving for aerospace industries. Harold Herkenhine has been appointed chief engineer for production products. He has been chief engineer of Koehler since 1958. His new position will be devoted to research and development of valving and control systems.

LaFontaine

Herkenhine

Warren to manage development engineering

Atlee Corp., Waltham, Mass., has named Bernard J. Warren manager of development engineering. Atlee is a recent combine of four New England companies: Atlee, Wesco Electrical Co., Inc., Applied Dynamics, and Industrial Electronics Co., Inc. Products include hydraulic and pneumatic systems for airborne and ground-based radar. Warren was general manager of Applied Dynamics Div. ▼▼▼



Vacco advanced design probably offers more than you had hoped for . . in performance latitude . . hi-pressure capacity . . field interchangeability . . low torque loading . . bubble tight operation . . instantaneous electronic response and over-all reliability.

Check your specifications for hi-performance valves and regulators . . and specify Vacco to be sure.

Vacco offers a complete line of solenoid operated valves, pressure regulator valves, manual valves, cylinder operated valves, and back pressure regulators.

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Range: 5 Micron Vacuum to 10,000 PSI
Temperature: —452°F to +1,000°F

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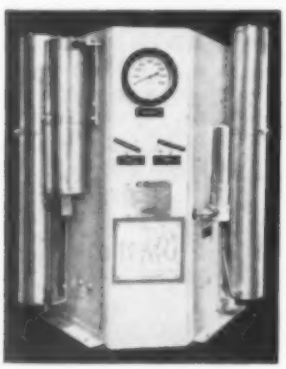

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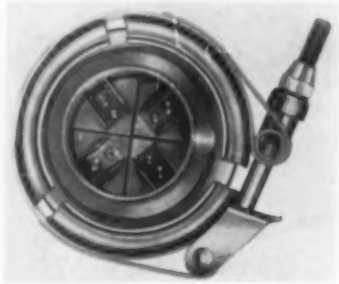
AEROSPACE COMPONENT DATA

Multi-Flapper Check Valves & Joints

Features: Dynamic forces in the multi-flapper valve are much lower than in equivalent, single-flapper design. Lightweight materials and small valve bodies can be used, reducing weight of airborne pneumatic and fuel systems.
When used with Marman joints, there is a significant saving in envelope size and weight. The quick-coupler latch of the joint allows the valve to be quickly and easily installed.

Specifications: These joints can be used on any standard tubing for fuel, hot air, and gas systems.



Designation: LJ11 and J13 joints. *—Marman Div., Aeroquip Corp., Los Angeles, Calif.*

Circle **500** on Reader-Service Card

Static and Dynamic Seals

Standard and special Omniseals for static and dynamic applications are described in folder. Both types of seals function from −450 F to 500 F, and have the chemical resistance of stainless steel. Performance tables and curves are given.*—Reid Enterprises, Inc., Long Beach, Calif.*

Circle **501** on Reader-Service Card

Primary Pressure Standard

Features: Provides digital display of a pressure input or positive indication when a desired pressure is reached. Used as a primary reference or for continuous duty as a secondary standard. In operational use with Jupiter missile squadrons. Has accuracy previously obtainable only under laboratory conditions. Takes advantage of the basic accuracy of a simple air deadweight tester.

Specifications: Typical accuracy of 0.02% over range of 0.4 to 250 psi, including all errors due to friction, hysteresis, temperature, repeatability, resolution, linearity, and readability.*—Wallace O. Leonard, Inc., Pasadena, Calif.*

Circle **502** on Reader-Service Card

Quick-Disconnect Couplings

Features: For use in cryogenic systems. Designed for Lockheed's Polaris Dolphin test program. Will withstand 10,000-psi burst pressure without deformation or damage.

Specifications: No leakage, coupled or uncoupled. Maximum of 30 in-lb to uncouple under extreme conditions.*—Aqualite Corp., Santa Monica, Calif.*

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Continued on page 96

CAPABILITY
is spelled
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In technology and facility, Vickers continually matches your need

Experience gained on every type of military aircraft and commercial airliner plus numerous missile applications assures top performance from every Vickers auxiliary power package. Either complete and separate power generating systems or motorpumps can be provided depending on specific application requirements.

Precise performance evaluation—particularly on motorpumps—can often be provided even before the final package is developed from proved standard elements by building up prototype units and subjecting them to feasibility and performance tests. From these prototypes come the ultimate custom designed packages providing a high order of reliability and requiring minimum input power—all in a compact, lightweight envelope.

Additional data is available in two new Vickers bulletins: A-5239 "Power Systems" and A-5258 "Motorpumps". Write for your copies to either address listed below.

All components of Vickers auxiliary power units are subjected to thorough inspection by skilled technicians following evaluation tests. New size of standard element is shown being inspected following 40,000 rpm cycle test.

A. Battery-powered motorpumps developed for each stage of an ICBM missile.

B. Integrated motorpump for one of newest IRBM missiles.

C. Integrated AC motor-hydraulic power supply for intercontinental bomber turret drive.

Final testing, evaluation and assembly is performed in a special, surgically clean room. Thus, once parts are super-cleaned, no additional contamination is introduced.

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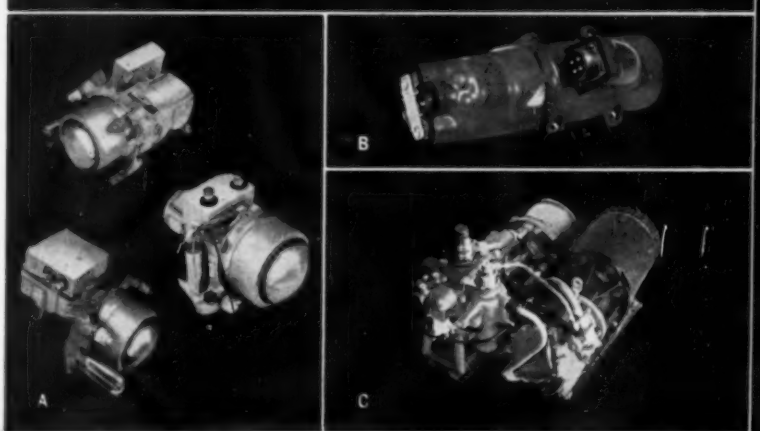

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POWER TRANSMISSION
ENERGY CONVERSION
FLUID TRANSFER

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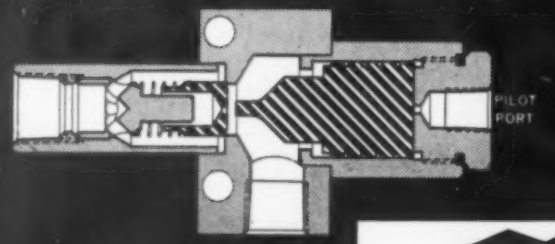
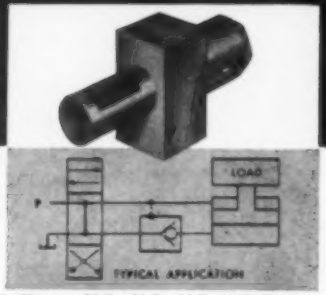


PILOT CHECK VALVES



- For clamping or holding circuits
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- Strong — all steel for long life.
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Part No.	Bore	Stroke	Eye-to-Eye Length	Shaft Dia.	PRICE
H-70A	2½"	8⅜"	18¾"	1½"	9.88
H-70B	2½"	10"	21¼"	1½"	10.88
H-70D	2½"	23¾"	35½"	1½"	18.88
H-70E	2½"	30"	40½"	1½"	24.88
H-70F	2½"	48½"	64⅜"	2"	29.88
H-70G	3½"	8"	19"	2"	17.88
H-70H	3½"	10¼"	21¼"	2"	19.88
H-70J	3½"	22½"	34¼"	2"	29.88
H-70K	3½"	30"	41"	1¾"	34.88
H-70L	3½"	43½"	55⅛"	1¾"	44.88
H-70M	3½"	47"	64½"	2"	49.88
H-70N	4"	22¼"	34⅜"	2"	36.88
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2250 PSI CORNELIUS COMPRESSOR AND 115 V. MOTOR
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Made up of a surplus Cornelius compressor combined with a new 1/2 HP, 115/220 V., 60 cycle AC electric motor . . . a mounting frame and built-in carrying handle. It's tested to 3,000 PSI. Will deliver 0.6 CFM. Ideal for use wherever high pressure air is desired . . . to fill air tanks, use in laboratory, etc. SAVE at our low price.

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AEROSPACE COMPONENT DATA

Fluorocarbon Resin for Gasketing and Packing

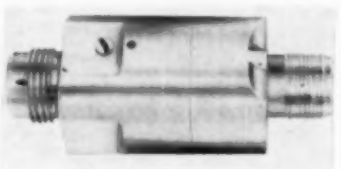
Features: A new family of gasketing and packing materials of fluorocarbon resins reinforced with inorganic fibers can be used at temperatures from −425 to 500 F with excellent torque retention and is unaffected by common fuels and hydraulic fluids. Their outstanding resistance to deformation under load and cold flow is not equaled by any other fluorocarbon. Their low coefficient of friction makes them useful as seals and packings in contact with moving parts. The material has good dielectric properties and excellent thermal dimensional stability.

Designation: Fluorocarbon Accopacs.—*Armstrong Cork Co., Industrial Div., Lancaster, Pa.*

Circle **504** on Reader-Service Card

Pneumatic Pilot Valve

Features: For actuation or large control valves. Inlet and vent ports are screened. Housing is aluminum alloy.



Specifications: Valve is 3⅛" long, has a small flow. Available as NO and NC, 2- and 3-way, 3000 psi. 10,000-psi burst. Operated on 18-30 vdc through standard MS receptacle or pigtails.

Designation: PLV-1 series.—*Marotta Valve Corp., Boonton, N. J.*

Circle **505** on Reader-Service Card

Miniature Hydraulic Motor

Features: Hydraulic servo motor, less than one cu. in. in size, controls missile antennas as they track moving targets. Suited for missile and satellite applications where high power is needed in small space. Motor receives electronic commands through a miniature hydraulic servovalve. It maintains smooth rather than pulsing motion, even at low speeds, so movement

Continued on page 98

HOKE Flow Sheet 3

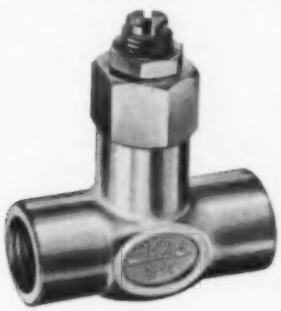
HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

How Do You Gauge Protection?

Not that we're trying to put an end to our pressure gauge business, but the new Hoke gauge protector will save you quite a bit of money on gauge repairs and replacement. It will help soothe the savage temper of your maintenance man, which might be even more important.

The new 530 Series gauge protector prevents sudden pressure surges from damaging costly gauges. Mounted conveniently, and directly between the pressure source and the gauge, it can be set for any pressure protection point between 30 and 1000 psig and will handle inlet pressures to 3000 psig. Minimum burst pressure is 9000 psig, so you have a



good safety margin. Its widespread popularity among maintenance men is due to the fact that it does not have to be re-set when the pressure drops below the protection point.

Those more interested in technicalities should read this: The temperature range is −10° to +200° F, and the unit is usable in any clean gaseous service compatible with brass and Buna-N. It weighs only 5¼ ounces, and measures 1⅞ inches from inlet to outlet. Both ends are ¼ NPT female connections, so no adaptors or connectors are necessary for installation.

Specs are available, whatever your reason for wanting them—Write!

SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.

Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination—they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hookup is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.

Size-wise, we're offering them in ½, ¾, 1, 1½, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

WHAT'S NEW FROM HOKE?

Lots of things have been happening at Hoke. To be sure you're up to date on these developments in fluid control see your nearest distributor. He'll have something new for you every other month this year.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

HOKE, INCORPORATED
87 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

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- ☐ 530 Gauge Protectors
- ☐ Flow Sheet
- ☐ "What's New"
- ☐ Complete Catalog GC 960

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COMPANY _____

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DOUBLE-ACTING CYLINDERS

No. AOC 562—2¼" bore, 9" stroke, 1½" dia. stainless steel shaft. Aluminum alloy cylinder. ¼" tubing thread ports. Overall length closed 24½". Shpg. wt. 15 lbs. F. O. B. Chicago **$17.95**

No. AO16C—1½" bore, 24" stroke, 1" dia. stainless steel piston rod. Will lift 1760 lbs. with 1000 lbs. pump pressure. POSTPAID **$16.95**

BRAND NEW ROTARY VANE VICKERS HYDRAULIC PUMP

Model 2035XS93—capacity 27 GPM at 1200 RPM 1000 PSI. Front flange mounting, supplied without flange adaptor. Shpg. wt. 55 lbs. F.O.B. Chicago.

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MULTI-PURPOSE HYDRAULIC PUMP OR MOTOR

Silent—ball bearing, high efficiency helical gear type. Rated 8 GPM at 1500 RPM, 1000 PSI, using 6 HP reversible rotation. ¾" pipe thread inlet & outlet ports, ¼" drain port, ¾" shaft with keyway & flat for direct/pulley drive. 5⅝" h., 7¼" l., 5⅛" w. Shpg. wt. 18 lbs. F.O.B. Chicago. No. AO55 ..... **$52.50**

COMPACT PUMP FOR DIRECT/BELT DRIVE WHERE SPACE IS LIMITED

PESCO gear type hydraulic pump, cont. duty, positive displacement. 0.993 cu. in./rev. Delivers 6 GPM at 1600 RPM, 1200 PSI. Clockwise rotation. Requires 7 HP. Speed range 400-2000 RPM. Max. pressure 1500 PSI. Max. delivery 7.5 GPM at 2000 RPM. ¾" pipe thread ports, ¾" shaft with Woodruff keyway. 2 hole base mounting. 5" l., 4½" w., 7¼" h Shpg wt. 11 lbs. F.O.B. Chicago. No. AO160R **$24.50**

4-WAY HYDRAULIC CONTROL VALVE

Groban top quality valve, with built-in adjustable pressure relief control factory set at 1000 PSI. Fully balanced plunger type, self-centering, designed to actuate one set of double-acting cylinders. Can be used as single unit or in series. 4 mounting holes in base. Capacity 16 GPM . . . Pressure range 250-1500 PSI. Pipe thread connections—¾" inlet & outlet, ½" cylinder openings. 8⅛" l., 4" w. Shpg. wt. 8 lbs. F.O.B Chicago. No. AO126 ..... **$23.50**

(17 Variations also Available at Same Prices)

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Circle **42** on Reader-Service Card

AEROSPACE COMPONENT DATA

controlled by the motor is instant and precise. Its oil porting method permits rapid reversal.

Specifications: Weighs 4 oz. ⅝ hp at 6000 rpm. Displacement is 0.02 cut in./rev.—*The Bendix Corp., Bendix Hamilton Div., Hamilton, Ohio.*

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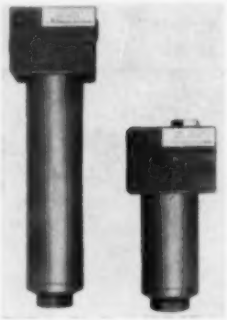
Custom Designed Motorpumps

For aerospace applications where a separate power source is more efficient than extending the hydraulic system. They permit precise performance evaluation before the final package is developed. Explosion proof per MIL-E-5272-C. Bulletin A-5258 provides dimensional data, performance curves, and operating ranges of fixed and variable displacement piston pumps and fixed displacement vane pumps. Outline of information needed to develop a custom motorpump is given.—*Vickers, Inc., Aero Hydraulics Div., Detroit, Mich.*

Circle **507** on Reader-Service Card

Cartridge Filter For Servos

Features: Filter gives choice of either 10-gpm or 20-gpm flows using a single size filter element of either 5 or 25 micron rating. Manifolding the 10-gpm elements produces unlimited flow rates. Has integral relief valve.



Specifications: Pressure rating, 3000 psi. Useable with standard hydraulic oils, MIL-0-5606 oils, and phosphate ester base fluids. Connections are ½" NPTF. AND-10050-8 or subplate connections available. Cartridge element is resin impregnated cellulose. Technical Bulletin 91419 describes filter.—*Boonshaft and Fuchs Inc., Hatboro, Pa.*

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You can win up to $500...

...by entering the

1961 FLUID POWER PRIZE PAPER CONTEST

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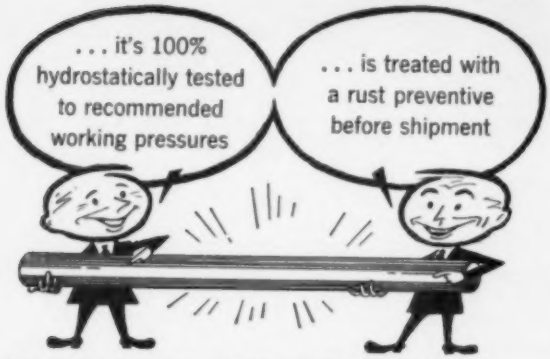

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- **Ease in bending and flaring,** with no loss of ductility in storage or service—by use of 0.12% max. carbon non-aging steel.
- **Consistently uniform tubing**—by careful inspection of raw material and tubing in process.
- **Bright scalefree OD and ID**—by controlled atmosphere annealing.
- **Smooth ID** by mandrel drawing close to finish size.
- **Assured cleanliness** by hot solvent degreasing before process anneals and shipment.
- **Flare-inspected quality** based on 35% increase of OD.
- **All tubing boxed and wrapped** for cleanliness and to protect against bending and denting during shipment or in warehouse storage.
- **Complete range of sizes** stocked and sold by leading steel "Service Centers."

SEND FOR YOUR COPY Bulletin 39, containing bending data, working and bursting pressures, and flow information. Handy reference material for your files. Write Superior Tube Company, 2030 Germantown Ave., Norristown, Pa.

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All analyses .010 in. to ⅛ in. OD—certain analyses in light walls up to 2½ in. OD

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1590 GAGE PRESSURE SWITCH
3" x 0.937"
2½ ounces max.

Haydon Gage or Absolute Pressure Switches are easily tailored to specific pressure settings and environmental conditions. They have a pressure range of 10 psi to 3,000 psi, and have SPDT circuitry with sealed or unsealed snap-action switches.

These Pressure Switches meet applicable portions of MIL-E-5272, high and low temperature, shock and vibration.

1890 ABSOLUTE PRESSURE SWITCH
2¼" x 0.875"
2½ ounces max.

Write now for Bulletins 1590 and 1890, which give design specifications, electrical and environmental data, and applications.

HAYDON Switch INCORPORATED

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STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTORS

Mark IV—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1—100 R.P.M. reversible). Overall efficiency 90%—95%.
Mark V—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1—75 R.P.M. reversible). Overall efficiency 90%—95%.
Ideal drive for conveyors, rolling mills, cranes, tractors, cement mixers, drills, and most mechanical handling applications.

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Standard equipment includes 2"—4" formers for steam and gas pipes. The machine can be supplied either **Hand Operated** or **Motorised** and accessories are available for ¾"—1½" steam and gas pipes, flat bar bending up to 7" x ¾" section and electrical conduits up to 3".

A complete range of Hydraulic Pipe and Tube Benders ¼" to 18" dia. Pipes is available.

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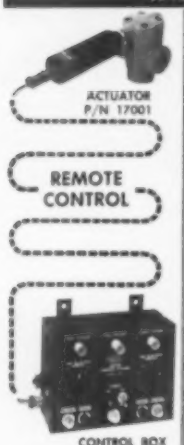
SMOOTH AND LINEAR PRESSURE BUILD UP AND DECAY FROM A FEW SECONDS TO SEVERAL HOURS



Motorized actuator replaces manual screw in relief valve to set minimum and maximum pressure.

Actuator motors available to give base time of full pressure variation from 6 seconds to 2 hours. Control box provides 8/1 extension of base time, adjustable continuously over full range. Push button operation after selected time is dialed in.

Control box has internal provisions for interlocking to existing circuits.

Servo operated systems available to provide pressure response to any transduced signal such as temperature, position or dimension.

Standard systems under $500.00.

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AUTO-PONENT®
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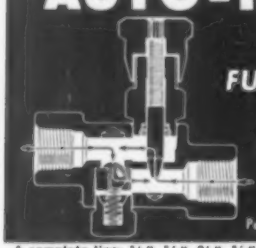
***FULL FLOW* VALVES**



Flow Control, Needle, Check, for HYDRAULIC Power

Model KF Flow Control Valve with Dial and Knob adjustment for direct reading and duplicating reference. Now available in Aluminum for 3000 psi.

Pat. #2,841,174

A complete line: 1/8", 1/4", 3/8", 1/2", and 3/4" female Dryseal Pipe Sizes in all models and types. Equivalent Aeronautical Tube Sizes on special order.

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure greater accuracy and response in hydraulic or large volume air cylinder control.

EASY FLOW ADJUSTMENTS under full pressure. Seal located at port to eliminate air or dirt traps. Gland structure equally effective on pressure or vacuum.

SENSITIVE, CHATTERLESS BALL CHECK . . . Patented design insures rapid ball movement to open or close at low differentials.

FORGED BODIES permit higher pressures with wide safety margins. Aluminum—3000 psi; Steel and Stainless Steel—5,000 psi. Pressure ratings based on better than 5 to 1 safety factor. All internal parts are Stainless. Write for illustrated catalog.

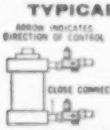
Model F Standard Flow Control Valve or Model N Needle Valve

Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.

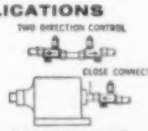
Model PF Knob and Dial Flow Control Valve or Model PN Needle Valve. For panel mounting.

Model C Check Valve for In-Line Mounting.

TYPICAL APPLICATIONS



Controlling Double Acting Cylinder



Controlling Single Acting Cylinder

AUTOMATION AUTO PONENTS INC 2919 GRANT STREET BELLWOOD (Chicago Suburb) ILLINOIS

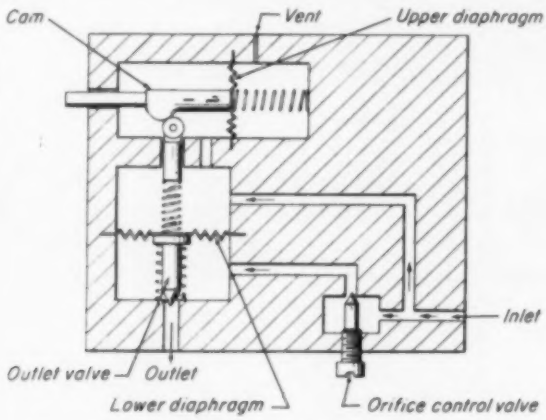
Circle **120** on Reader-Service Card

FLUID POWER PATENTS

Flow Control Valve

This valve controls flow in any desired relationship to incoming pressure. The valve relates the pressure drop through an orifice to inlet pressure.

• **How it Works**—Fluid at variable pressure enters the valve through the inlet connection. It flows through an adjustable orifice to the bottom of the lower diaphragm. Inlet pressure is also ported to the top of the lower diaphragm and the left side of the upper diaphragm. As the lower diaphragm raises and lowers, it opens and closes the outlet valve, controlling flow. The cam in the upper valve chamber is attached to the upper diaphragm. As inlet pressure increases, the diaphragm and the cam move right against the force of the diaphragm spring. This cam movement pushes the cam follower down increasing the spring force acting down on the lower diaphragm.



Shape of the cam determines the relationship between inlet pressure and flow. Usually, flow through the orifice is proportional to the square root of the pressure drop across it. By proper cam shape and spring selection, the relation between pressure drop and flow can be linear, or can follow any desired pattern.

U. S. Patent No. 2,942,619 *by Harold E. Jackson, assigned to Tecalemit Ltd., Brentford, England.*

Cylinder Synchronizing

The system extends or retracts cylinders in unison regardless of the load on each cylinder. It senses and corrects immediately if one cylinder is out of synchronization.

The drawing shows the system controlling three cylinders. It has two hydraulic circuits, one is a synchronizing circuit and the other supplies hydraulic fluid to actuate the cylinders. The synchronizing circuit is a closed system connected to cam-operated

Cleveland Series "J" Wheel-Type Trencher. Spoil conveyor is powered by Sundstrand hydraulic pump.

Sundstrand Hydraulics—the proved way to increase the efficiency of auxiliary drives

Today Sundstrand hydraulic power transmission components and systems are providing greater operating efficiency and ease of control for a wide variety of equipment—road graders, combines and other farm machinery, mining equipment, trenchers, and many others.

On the Cleveland Trencher "J" series machine (above) a Sundstrand pump powers the spoil discharge conveyor—replacing mechanical drive from the digging wheel. Changing to the Sundstrand powered hydraulic system helped boost the efficiency of the trencher *and* win increased customer approval.

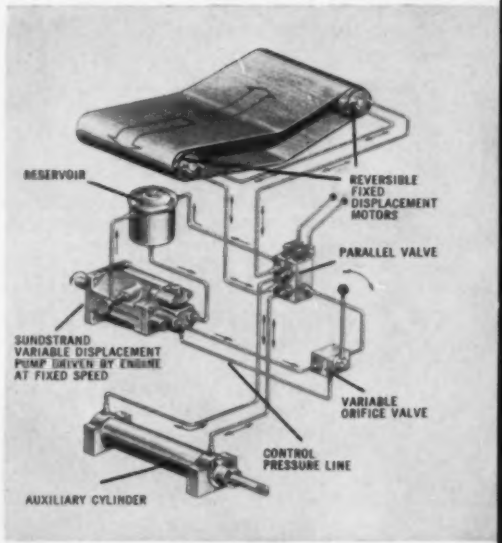
THE SYSTEM consists of a Sundstrand variable displacement pump, a variable orifice valve and two reversible fixed displacement hydraulic motors. The pump delivers *only* the fluid needed to maintain a selected conveyor speed. Power is not wasted pumping oil through bypass circuits when full power (or speed) is not required. As a result, the reservoir can be smaller, more compact and heat build-up is less. System design and assembly are easier for the manufacturer. The user benefits, too, in greater reliability and reduced maintenance.

HOW IT WORKS. The conveyor drive is designed so pump displacement can be controlled from a remote point by a variable orifice valve. A pressure change across the valve is reflected back to the Sundstrand pump through the control pressure line. This signals the pump to change displacement. Varying the orifice size results in a corresponding change in pump displacement.

With the new drive, hard digging no longer means a slow-up in the discharge rate as it did when conveyors were powered by the digging wheel. Now speed of the conveyor is controlled independently . . . set at the most efficient speed to match digging rate of the machine.

CONVEYOR DRIVE REVERSIBLE. Often job requirements dictate on which side of the trench the spoil is to be discharged. With the versatility of hydraulic power, the conveyor can be easily shifted to the proper side and discharge reversed simply by touching a convenient control lever in front of operator.

This application illustrates a few of the important operating and sales advantages made possible by Sundstrand drives. A compact, highly efficient Sundstrand hydraulic power transmission system can be the answer to *your* auxiliary power requirements.



If you would like more information about the many application possibilities of Sundstrand hydraulic components and systems, write outlining your requirements to:

Mr. Ray Murphy, *Application Engineer*

SUNDSTRAND HYDRAULICS
DIVISION OF SUNDSTRAND CORPORATION
2210 Harrison Avenue • Rockford, Illinois

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LOCK OUT AIR FOR MACHINE REPAIR

Ross

Locks
Out and
e**X**hausts
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Lock out air that operates a machine, as a safeguard when making machine repairs. The Ross L-O-X Valve installs in the supply line leading to the machine, upstream of any operating valve. Designed so that when closed, supply-air to the machine is shut off and air downstream is exhausted. Can be padlocked in this position.

More L-O-X valves can be incorporated in the circuit to shut off and exhaust various segments of the circuit. Detented open; very low pressure drop; Lightweight aluminum construction. Call your Ross representative or write for literature.

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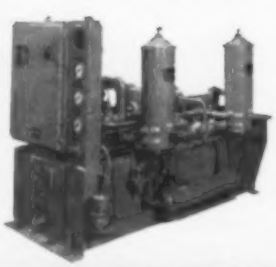

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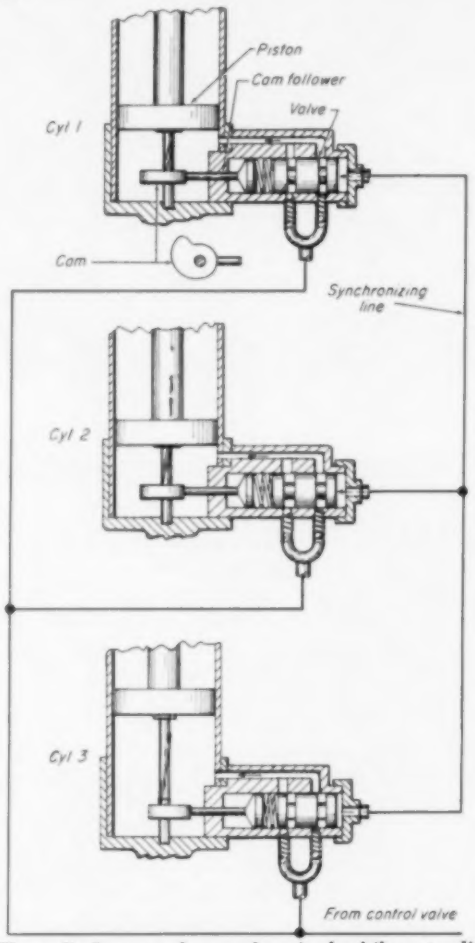
Quality A CARDWELL TRADITION SINCE 1825
Franklin at 19th St. Richmond 11, Virginia • Phone Milton 4-4593

Circle **15** on Reader-Service Card

FLUID POWER PATENTS

valves at each cylinder. A spirally-grooved shaft connected to each piston rotates the cams.

As the pistons move, the cams rotate, moving the cam follower in and out. This cam movement increases or decreases spring force on the valve spool. The spring force is transmitted to the confined fluid in the synchronizing circuit. If spring force increases at one valve, its spool moves, decreasing the quantity of hydraulic fluid to its cylinder. This spool movement also forces synchronizing fluid into the other valves, moving their spools increasing fluid flow to their cylinders.



The cylinders can be synchronized while extending or retracting. The valves meter-in fluid while extending the cylinders, and meter fluid out while retracting.

In the drawing, cylinder 3 has compressed the than cylinders 1 & 2. Its cam has compressed the spring, moving the valve spool right, reducing the orifice through which hydraulic fluid flows to the cylinder. Synchronizing fluid displaced from the valve flows into the valves on cylinders 1 and 2, moving their spools left. This increases the flow of hydraulic fluid to cylinders 1 and 2 until the cylinders are all synchronized.

Prepared from a U. S. patent application by Ollie G. Douglas, Elizabethtown, Ky.

Circle **98** on Reader-Service Card

Accurate, Automatic temperature control

OF HYDRAULIC AND HEAT TRANSFER FLUIDS

Peak performance of hydraulic equipment is assured by the precise, dependable oil temperature control maintained by the Sterlco Temperature Control Valve, Series 150E. It's completely automatic, self-contained, compact and low cost . . . operates in any position. Write for details.

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Saves hours in piping installations

PAT. PENDING

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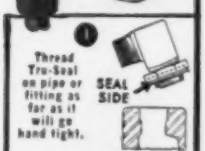
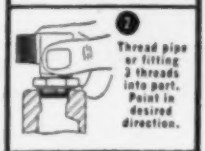
Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.





For further information write

TRU-SEAL DIVISION
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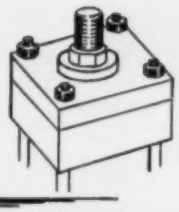
7N017 York Rd., Bensenville, Ill.

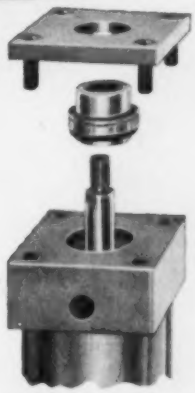
"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.

Circle **105** on Reader-Service Card

Why This?



When This Can Be Yours!



Mo-Bar Air and Hydraulic Cylinders cannot fall apart . . . because of loose tie-rods . . . when you remove the rod bushing and cartridge retainer plate of these cylinders.

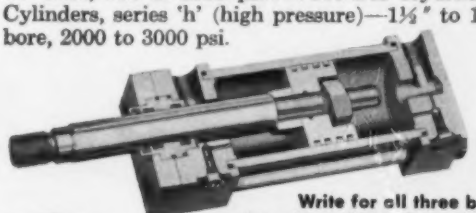
Mo-Bar's *exclusive* feature of using four (4) Allen Head cap screws in place of conventional protruding hex nuts . . . permits easy, quick replacement of the entire cylinder Rod Cartridge assembly . . . with cylinder barrel and tie-rods always permanently in place.

This Mo-Bar "first" gives greater design flexibility . . . particularly for cylinder mounting in tight places.

Other Mo-Bar "firsts" include (1) improved Rod Cartridge design where the long bronze rod bushing is *piloted* into cylinder head—not threaded —for maximum piston rod support . . . and (2) oil-heat resistant, self-adjusting Seal Guard wiper rings, with long conical taper, to throw off all harmful matter from piston rods.

The unique Mo-Bar compact design for air and hydraulic cylinders assures superior performance and unfailing dependability with positive, uniform actuation at all times.

There are Mo-Bar Air Cylinders, series 'a'—1½" to 14" bore, to 200 psi . . . Mo-Bar Hydraulic Cylinders, series 'm' (medium pressure)—1½" to 14" bore, 500 to 2000 psi . . . Mo-Bar Hydraulic Cylinders, series 'h' (high pressure)—1½" to 12" bore, 2000 to 3000 psi.



Write for all three bulletins—Nos. 202, 203 and 204 —describing Mo-Bar Air and Hydraulic Cylinders for fluid power applications . . . Dept. B

MO-BAR
HYDRAULICS CO.
Crystal Lake, Illinois

Circle **70** on Reader-Service Card

Ask for performance curves and specifications on the new H-P-M relief valves. See for yourself the built-in values.

Just how important is the close control of operating pressures in your circuit? H-P-M relief valves offer remarkably low differential between cracking and override pressures in a range from 0 to 3000 psi. This built-in accuracy gives closer control of machine motions; protects the system from damaging override pressures; provides the instant reaction you need for better machine operation. H-P-M relief valves are performance proven in industry, in ground support hydraulics, in just about every field of hydraulics. Available in ⅜", ¾" and 1¼" sizes, interchangeable with industry standards, subplate mountings, 3000 psi, 6 gpm to 65 gpm capacities. Write for full information.

⅜" Relief Valve
3000 psi, 6 gpm

¾" Relief Valve
3000 psi, 20 gpm

1¼" Relief Valve
3000 psi, 65 gpm

H-P-M DIVISION • Koehring Company
Mt. Gilead, Ohio, U.S.A.

HPM

H126

Circle **43** on Reader-Service Card

NEW PRODUCTS

Continued from page 42

TRANSPARENT DRAIN

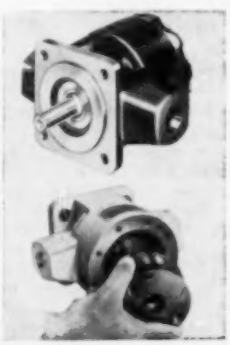
Drain is attached to tank, sump, or line that needs periodic draining. For compressed air tanks and air lines. Equipped with transparent bowl and drain cock. Provides visible sump which can be manually drained. Drain has no mechanism to foul. Requires only one connection.

Specifications: Inlet is ½" female PT. Overall height 6-¾". Largest diameter 5". Transparent sump capacity 1 pint. For pressures to 150 psi, and temperatures to 120 F. Not affected by water, naphtalene, motor oils, ammonia and others.
Designation: Model 5300-4—*Wilkerson Corp., Englewood, Colo.*

Circle **318** on Reader-Service Card

VANE PUMP

Single and double vane pumps have cartridge construction. Units can be serviced in minutes. No special tools required to replace



cartridge, or change to different capacity. All models internally drained. Pumps may be driven with flexible coupling, gear chain, or belt. Designed for industrial and mobile equipment applications.

Continued on page 106

Circle **115** on Reader-Service Card

Needed Now

Engineers-Loop:

To take technical cognizance of loop operation and assist in installation and in shakedown operation of loops. B.S. degree in electrical, mechanical or chemical engineering, with 1-3 years engineering or plant operation experience in the field of high-pressure water tests.

If you qualify for the above position, write immediately to: Mr. C. S. Southard, Westinghouse Atomic Power Division, P.O. Box 355, Dept. X-54, Pittsburgh 30, Pa.

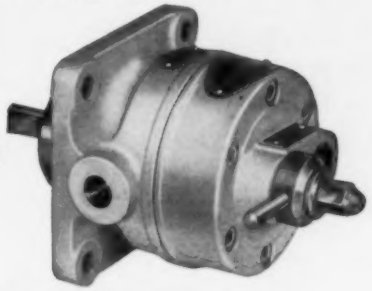
Westinghouse

ATOMIC POWER DIVISION

FIRST IN ATOMIC POWER

Circle **96** on Reader-Service Card

Pressures up to 1,500 p.s.i. with running speeds from 20 to 1,500 r.p.m. are possible with



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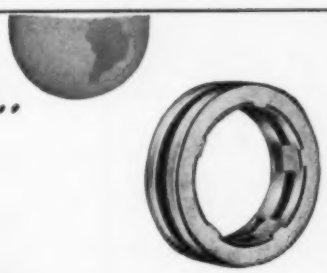
HYDRAULIC PUMPS

THOMAS SAVERY PUMPS LIMITED
BRACEBRIDGE ST., BIRMINGHAM, 6 ENGLAND

American and Canadian Agents:—
DAVIES BROTHERS, Gladstone, New Jersey, U.S.A. PEapack 8-1290

"All the world's Our stage"...

Manufacturers all over the world have discovered the importance of fitting 'SUPERFECT' Oil Seals and Hydraulic Packings for perfect performance under the most exacting conditions.



There is a type of Seal to meet virtually every need. Our Research Department is available to help solve any sealing problems.

A brand new catalogue is in the course of preparation. May we reserve one for you?

SUPERFECT

SUPER OIL SEALS & GASKETS LTD.
KINGS NORTON FACTORY CENTRE,
BIRMINGHAM 30 • ENGLAND

Circle **103** on Reader-Service Card

Circle **2** on Reader-Service Card

CUT AIR TOOL MAINTENANCE COSTS...

with Clean-Dry Compressed Air!

ADAMS AFTERCOOLERS provide virtually complete condensation of tool-damaging oil, moisture and dirt from pipeline gases — by efficient cooling to within 10°F. of the cooling water. ADAMS CYCLONE SEPARATORS then remove this condensate at a constant high-efficiency separation factor over all load ranges.

Adams offers this outstanding performance at substantial savings, made possible through specialization in Aftercoolers and Cyclone Separators — plus quality manufacturing methods developed over the years.

Investigate this low-cost method of protecting your pneumatic tools — write today for Bulletin 714! R. P. Adams Co., Inc., 249 East Park Drive, Buffalo 17, New York.

ADAMS *QUALITY COMES THROUGH*

NOW FOUR MODEL GROUPS

BERRY/DOWTY* hydraulic gear pumps

Pressures to 3000 PSI / Outputs: 1/2 to 85 GPM

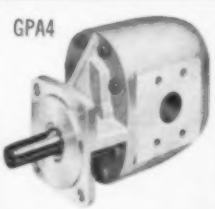
Berry's wide range of pump operating speeds, pressures and temperatures allows you to select the unit to meet your exact requirements. Metered, pressurized lubrication assures you of trouble-free performance. Volumetric efficiency of 95% at 2000 PSI minimizes input horsepower.

GPA1

GPA2

GPA3

GPA4



Berry HYDRAULICS
A DIVISION OF OLIVER TYRONE CORPORATION

*Dowty is the tradename of Dowty Hydraulic Units Limited, England.

MAIL FOR CATALOG
Berry Hydraulics, Corinth 1, Mississippi

Name_____
Company_____
Address_____

Circle **13** on Reader-Service Card

NEW PRODUCTS

Specifications: cw or ccw rotation. 2000 psi. Capacities 3, 5, 8, 11 gpm for single pumps. Combination of any two cartridges for double pumps.

Designation: PF100 Series—*Hydreco Div., New York Air Brake, Kalamazoo, Mich.*

Circle **319** on Reader-Service Card

AIR VALVES

Square-bodied valves are manual and mechanical. Available in 2 or 3-way NO or NC. Bodies, levers, and bases are machined from bar stock or cast. Types are ball-bearing cam, lever and roller-type cam, push-button, palm-button, palm-button with hold, vertical lever, and telegraph key lever. Choice of vertical or horizontal mounting.

Specifications: ¾" size. Capacity 80.04 cfm at 100 psi. Cam-operated valves can be actuated at over 30,000 cycles per hour. *Humphrey Products Div., General Gas Light Co., Kalamazoo.*

Circle **320** on Reader-Service Card

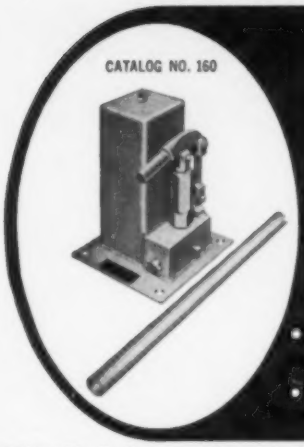
SUBMERSIBLE A-C MOTORS

Pressure-proof motors designed for close-coupling to centrifugal pumps. Operates in any depth of water, oil, or liquid chemicals. Sizes ½ through 40 hp for operation from polyphase power sources. Single phase connection from ¾ through 5 hp. One-piece, ribbed housing is leakproof. Cast iron motor frame and mounting are impervious to corrosion.

Specifications: Rated at 55 C temperature rise for 30-minute duty in 40 C air, and for continuous duty in 40 C liquids. *Reliance Electric and Engineering Co., Cleveland, Ohio.* ▼▼▼

Circle **321** on Reader-Service Card

Circle **85** on Reader-Service Card



Hand Hydraulic Pumps

- Single and Double Designs to 20,000 p.s.i.
- With or Without Reservoir

160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

for additional information write:

WILLIAM S. PINE

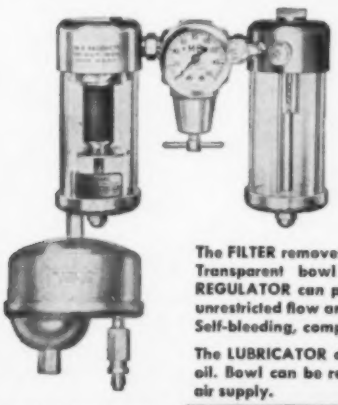
hydraulic hand pumps for 1001 uses

1635 East 22nd St., Los Angeles 11, Calif.

GREATER PROTECTION to your AIR LINE!

M·B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

M·B PRODUCTS
46 VICTOR AVE., Div. 12
DETROIT 3, MICHIGAN

Circle **65** on Reader-Service Card

PRECISION-BUILT

HYDRAULIC VALVES AND PUMPS..

to YOUR specifications

Over twenty years of specialized hydraulic valve and pump experience — newly enlarged, modernly equipped manufacturing facilities — an outstanding staff of thoroughly experienced craftsmen and an imposing list of satisfied customers is the best recommendation we can think of that you too will like our work.

Hydraulic valve and pump building is a highly specialized field demanding skills and equipment which many important companies have found too costly to maintain in their own plants. We are doing their work today.

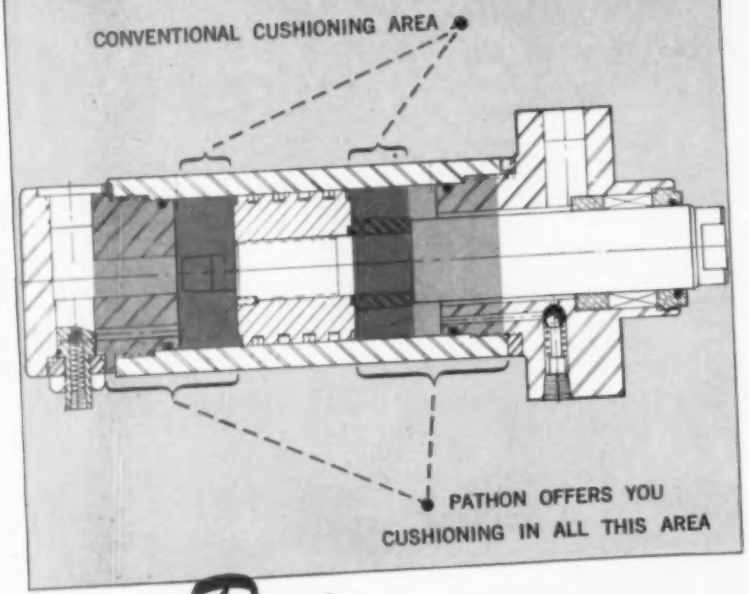
Why not invest a few minutes to hear the advantages of our service. It might well save you money and headaches.

HYDRAULIC ACCESSORIES CO.

24301 Hoover Road, Warren (Detroit) Mich.

Circle **51** on Reader-Service Card

NOW! CHOOSE THE CUSHIONING TO EXACTLY FIT YOUR REQUIREMENTS!



Another **Pathon** *First !*

High speed cylinder operations frequently require more refined deceleration techniques than ordinary cylinder cushions.

Now, Pathon cylinders are available with adjustable or non-adjustable cushions that are three to four times longer than ordinary cushions to provide the effective control required.

This extra length does not increase standard catalog dimensions and you can customs-specify any length or configuration up to the maximum.

Write for "LET'S TALK CUSHIONS" for details.

Pathon MANUFACTURING COMPANY

3823 Pacific Avenue, Cincinnati 12, Ohio

FLUID OPERATED AND CONTROL EQUIPMENT

Circle **84** on Reader-Service Card

USEFUL LITERATURE

Continued from page 48

CONTROL PANELS

Panels combine circuit design, device selection, and arrangement in one unit. Motor starters (up to 200 hp at 600 volts), circuit breakers, contactors, control transformers, rectifiers, push buttons, relays and timers. Machine, wall, or floor mountings. Bulletin GEA-6334A. specific.—*General Electric Co., Schenectady 5, N. Y.*

Circle **416** on Reader-Service Card

HYDRAULIC PRESSES

Brochure describes presses up to 150 tons capacity. Radial feature gives operator choice of three work stations. 150-ton press for forming abrasive cut-off wheels was built to be operated from any one of four sides with power package ten feet from press. Fourteen presses described to show company's design capability.—*St. Lawrence Hydraulic Co., Taylor, Michigan.*

Circle **417** on Reader-Service Card

MOBILE EQUIPMENT VALVES

Directional control valves for earth moving, mining, materials handling, agriculture, and ground support equipment. Bulletin 100-P16 gives construction details, performance and dimensional data for series 20 and 35.—*Commercial Shearing & Stamping Co., Youngstown, Ohio.*

Circle **418** on Reader-Service Card

TEMPERATURE-PRESSURE RECORDERS

24-hour, counter-clockwise rotation. 24-hour spring drive or 115 volt, 60 cycle synchronous motor rotations. Chart is 11¾", ¾" hole, 4¾" calibrated width. One, two, three, or four pens. Accuracy is ± 1% of total span. Catalog 800.—*U. S. Gauge Div. of American Machine & Metals, Inc., Sellersville, Pa.*

Circle **419** on Reader-Service Card

PROTECTIVE PLUGS

For pipe threads and hydraulic fittings. Made of flexible polyethylene. Sizes from ¼" to 3". In polypropylene for high temperatures. *Niagara Plastics, Erie.*

Circle **420** on Reader-Service Card

100,000-PSI GAGE

A secondary standard. Accurate to .1 of 1% of full scale. 270-deg. dial. Capacities from 0-15 to 100,000 psi. Dials are 8½", 12", 16". Hysteresis not greater than 0.1 of 1% of full scale after application of maximum scale pressure. External bleeder. External dial adjustment. Drawings show design and construction features.—*Heise Bourdon Tube Co., Inc., Newtown, Conn.*

Circle **421** on Reader-Service Card

FLUID RECONDITIONERS

Use as filter, reconditioner, transfer pump, flushing machine, or combination unit. Custom built or standard with relief valve, visulator strainer, transfer valve. Portable or stationary. Temperature range from 80 to 180 F.—*Mayhew Products Co., Los Angeles.*

Circle **422** on Reader-Service Card

DOUBLE PASSAGE ROTATING UNION

150-psi air, 1000-psi oil. 200 rpm maximum speed. Ball bearing and Oilite sleeve bearing eliminate radial load on O-ring. Housing fabricated from aluminum bar stock. Entrance connections prevent abnormal thrust loads. Model 1595. —*Deublin Co., Northbrook, Ill.*

Circle **423** on Reader-Service Card

FLUID POWER COMPONENTS

Condensed controls and equipment catalog. Illustrations and details of valves, cylinders, filters, lubricators, pumps, motors, accumulators, power units, and other components. Condensed catalog No. 601.—*Rucker Co., Oakland, Calif.*

Circle **424** on Reader-Service Card

AIR LEAK COST CHART

Card F-255-A shows comparison cost of compressed air leaks. Shows area of leak by diameter in fractions of inch, air loss by cubic feet per month at 75 psi, and dollar loss by cost of waste per month at $0.12 per 1000 cu ft. *Punch-Lok Co., Chicago.*

Circle **425** on Reader-Service Card

PLASTIC SEALANT

Thin, penetrating nature. Hardens by polymerization. Unaffected by liquids and temperature. Hardens only within the joint. Plastic bottles with applicator nozzle.—*American Sealants Co., Hartford.*

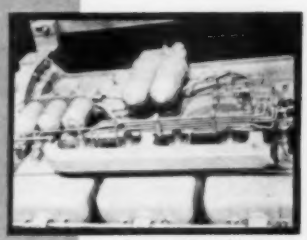
Circle **426** on Reader-Service Card

▼▼▼

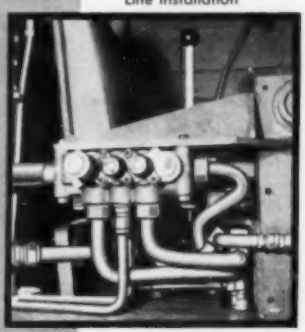
formrite TUBE COMPANY

specialists in design and fabrication of . . .

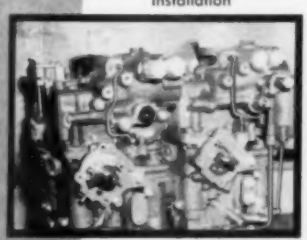
PRECISION FORMED METAL TUBES



Formrite Diesel Injection Line Installation



Formrite Valve Bank Installation



Formrite Aircraft Installation

Formrite specializes in the design and fabrication of precision formed metal tubes for fluid transfer lines. In addition, the firm has extensive lines of tube fittings in a wide variety of shapes and a large range of sizes. Forgings, castings and flange mounted fittings are also available and can be machined to exacting requirements.

Whatever your fluid transfer line requirements, they can be fulfilled by Formrite – a leader in engineered fluid transfer applications.

FORMRITE TUBE COMPANY
TWO RIVERS, WISCONSIN

Please send me the following catalog sections:

☐ Tubing & Fitting Section

☐ Hose Section

☐ J.I.C. Fitting Section

Name _____

Address _____

Company _____ Title _____

formrite TUBE COMPANY

TWO RIVERS, WISCONSIN
MEDINA, OHIO

Circle **33** on Reader-Service Card

You can be sure of Uniform Performance from O-M Cylinders

Internal Key Tie-Rodless Type Series 101A. Air—150 psi—up to 1500 psi Hydraulic. Fits where others won't. Bulletin 101A.

Whether you operate O-M Cylinders, of the same psi rating, bore and stroke, singly or in sequence, each one will exert the same force, handle the same work load, with the same precision. In addition, the direction of each stroke, length of each stroke as well as the time interval between cycles will be controlled to the same high degree of accuracy. As all parts and mounts of O-M Cylinders, of the same capacity, are micro-honed or accurately machined to the same close tolerances, they are interchangeable and precise. Uniform operation is automatic.

O-M Cylinders are available in a complete range of sizes (1½" to 8" bores) with standard or heavy-duty rods. Complete line of interchangeable parts and mounts. Immediate delivery on most sizes.

Coupon below will bring our latest bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data for each O-M Air and Hydraulic Cylinder. MAIL COUPON TODAY for your copies.

Bulletin 101A for Internal Key Tie-Rodless type Air and Hydraulic Cylinders featured above.
Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders Hydraulic 2000 psi; 3000 psi non-shock.
Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.
Bulletin 108—Automation (Heavy Duty) Hydraulic Cylinder—for 1000 psi operation.

ORTMAN-MILLER MACHINE COMPANY
1 143rd Street, Hammond, Indiana

Send Bulletins
☐ Have representative call ☐ 101A ☐ 105A ☐ 107 ☐ 108

Name_____ Position_____
Company_____
Address_____
City_____ Zone___ State_____

Circle **76** on Reader-Service Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Nunnemacher elected president of Galland-Henning

Hermann A. Nunnemacher, formerly executive vice president, has been elected president of Galland-Henning Manufacturing Co., Milwaukee. He has been with the firm since 1937, the last 20 years as manager of the Nopak Products Div. He succeeds his father, Henry J. Nunnemacher, president since 1917, who becomes chairman of the board.

Nunnemacher

Joseph

Young Radiator names sales manager

Burton M. Joseph is the new sales manager of the Industrial and Oil Field Div. of Young Radiator Co. Prior to his appointment, Joseph was general sales manager of Solar Chicago. A graduate of Illinois Institute of Technology, he has a B.S. in Chemical Engineering.

Divisions of IMC under new names

PSP Engineering Co. and Induction Motors of California, divisions of IMC Magnetics Corp., will now operate under the name of IMC Magnetics Corp., Western Div. The announcement was made by David Menkin, executive vice-president.

Hope rubber adds new department

A new department to handle hydraulic and pneumatic components will be formed by Hope Rubber Co., Inc. Herbert H. Walley Jr., will head the department. Within six months two engineers will be added to the staff.

Versa holds sales engineering forum

Versa Products Co., Inc., recently held its first national sales conference of franchised distributors. Eighty Versa distributors were there. At the three-day session, two new product lines were introduced. They were the explosion-proof valves and co-ordinates —an arrangement for mounting a number of valves in a single unit.

Continued on page 112

RAYBESTOS HOLDS OPEN HOUSE . . . Customers and suppliers attended an open house at Raybestos-Manhattan's new Pacific Coast Div. plant at Fullerton, Calif. The 25,000 sq ft air-conditioned plant has enlarged facilities to produce plastic products made of Teflon and Kel-F.

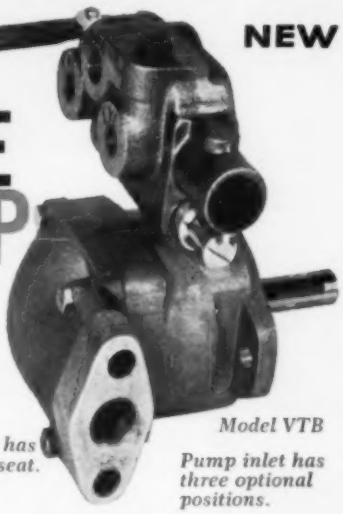
Circle **41** on Reader-Service Card

Adaptable!

NEW

Combination

VALVE -PUMP UNIT



- *Fully balanced valve spool.*
- *Spring loaded to neutral at center.*
- *Built-in relief valve has hardened replaceable seat.*
- *Detents optional.*

Model VTB

Pump inlet has three optional positions.

This complete hydraulic power and control system for hydraulic truck hoists and similar applications combines valve and pump in a single conveniently adaptable package. Vane type pump delivers up to 15 GPM, has 1500 PSI max. pressure. Convertible (3-way or 4-way) valve is useable with either single or double acting cylinders.

GRESEN HYDRAULICS

GRESEN
MANUFACTURING CO.

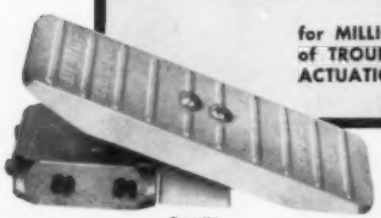
405 - 35th AVENUE N.E., MINNEAPOLIS 8, MINN.

---

new ROTORAM® VALVES

WITH EXCLUSIVE ROTATING STEM

for MILLIONS of TROUBLE-FREE ACTUATIONS



Treadle Valve

Knob Valve

- Low silhouette mounting
- 2024 T4 aluminum bar stock
- Rust-resistant
- Full flow air passages
- Piped exhaust ports
- Interchangeable parts
- Anodized finish

Cam Valve

Finger Valve

Pedal Valve

Hand Ball Valve

Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

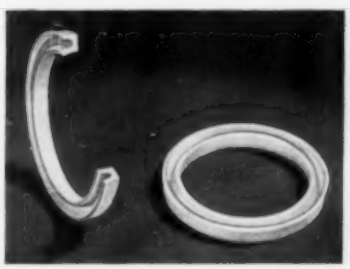
AIR-MITE DEVICES, INC.
4401 W. Kinzie St., Chicago 24, Ill.

Circle **4** on Reader-Service Card

H·I·S

PRECISION TEFLON* "U" Cups FOR LOW FRICTION----- ---HIGH TEMPERATURE in any hydraulic fluid

Style 4505 "U" cups are accurately machined of virgin TEFLON to a special design developed by HALOGEN. 246 standard sizes are available without tooling charges.



Also available:

HALOGEN "V" RINGS

two types available for packed cylinders and other applications.

Write for literature . . . our new 12 page brochure on "U" cups is yours for the asking.

HALOGEN
INSULATOR & SEAL CORP.
9960 Pacific Ave. • Franklin Park, Ill.
"Engineers and manufacturers— TEFLON Products"*

*DuPont T.M.

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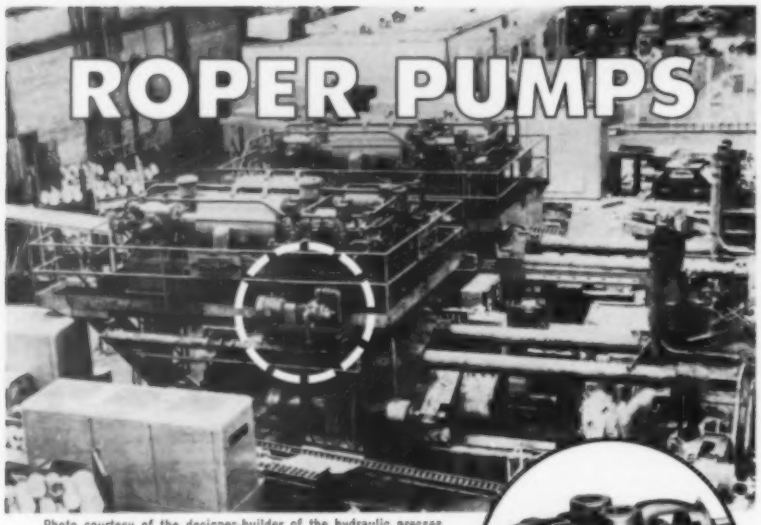
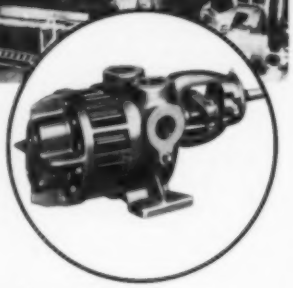


Photo courtesy of the designer-builder of the hydraulic presses



SERIES F Model 2F75 Spec. 35

pre-fill pump brings aluminum extrusion press hydraulic system to operating pressure

1-300 GPM CAPACITIES • OPERATING PRESSURES TO 300 PSI

The hydraulic system of this self-contained oil hydraulic four column aluminum extrusion press, designed and built by Birdsboro Corporation, relies on a Roper Series F pre-fill pump to fill the hydraulic cylinder with oil to operating pressure. The Roper pump was installed as original equipment when the press went into operation five years ago. The 200 SSU viscosity oil is pumped at the rate of 84 gpm and pressure of 125 psi as pump operates at 1140 rpm. Series F pumps are specially designed for transfer of clean liquids in applications such as hydraulic power pressure lubrication or fuel oil transfer. Pump has arrangement for circulation of oil through bearings to control their operating temperature.

INSIDE STORY OF SERIES F

- **PUMPING GEARS:** pair of six-toothed helical gears of heat-treated steel, accurately finished to keep pump running smoothly, quietly.
- **BEARINGS:** two bronze, flange-type bearings on each side give ample support to pumping elements which are self-cooled and lubricated by liquid being pumped.
- **BACKPLATE:** carries pipe connections, designed to permit removal of internal parts without disturbing piping or drive.

For information about your specific pump needs, contact your nearest Roper dealer

Send for "How to Solve Pumping Problems" booklet

ROPER HYDRAULICS, INC.

Dependable pumps since 1857

COMMERCE, GEORGIA

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POST SCRIPTS OF INDUSTRY

Wiedman named chief engineer

John A. Wiedman was made chief engineer of Industrial Div., Hydromatics, Inc., Bloomfield, N.J. He was section head of design engineering for Honeywell Valve Div., Fort Washington, Pa.

Sales positions filled at Cornelius

J. W. Mahanay, sales manager of Cornelius Co./Aero Div., Minneapolis, has announced three new positions in the sales department. J. Robert York formerly east coast sales engineer will be regional manager of the west coast division. York has been a Cornelius sales engineer for three years. George Krause, midwest field sales engineer, will be regional manager of the midwest sales area. He has been a sales engineer for the New York Airbrake Co. Paul Fournier will be regional manager of the east coast division after having been with Minneapolis Honeywell Corp.

York

Krause

Fournier

Weston Hydraulics founder dies

Ira E. Weston, founder and chairman of the Board of Weston Hydraulics Limited, Van Nuys, California, died Nov. 29, 1960. Weston served as president and

Continued on page 114

Circle **123** on Reader-Service Card

NEW LOW PRICES

on this "FINEST of the INTERCHANGEABLES"!

NEW "A" SERIES
(formerly C5 Series)

- 250 psi Air
- 13 Bore Sizes—1-1/8" to 14"
- 18 Standard Mountings
- Cartridge Quickly Removed Without Disassembly
- Sturdy Steel Head Construction
- Meets or Exceeds J.I.C. Standards
- Dimensionally Interchangeable with Other Makes

THE SHEFFER CORPORATION

Write, NOW, for New Bulletin #161

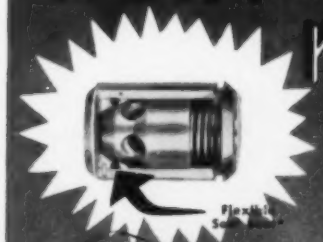
NFPA

SOLD BY LEADING DISTRIBUTORS INTERNATIONALLY

Cincinnati 15, Ohio
Phone POplar 1-8227

SEE PHONE BOOK YELLOW PAGES

NEW! KEPNER Kepsel



cartridge type valve insert

The Check Valve that cuts costs of Design and Installation 75% and more!

- Leak Proof—At All Pressures
- Low Pressure Drop at Full Flow
- Eliminates All Threaded Connections
- Eliminates Expensive Machining

Small in size—big in capacity—simple to install—the KEPNER Kepsel Cartridge Type Check Valve is designed for positive performance. Eliminates expensive machining, finishing of fine, close tolerances, metal surfaces—dirt can't hurt it.

Write for complete technical data

*Patent Applied For

KEPNER PRODUCTS COMPANY
7321 West 59th Street Summit, Illinois

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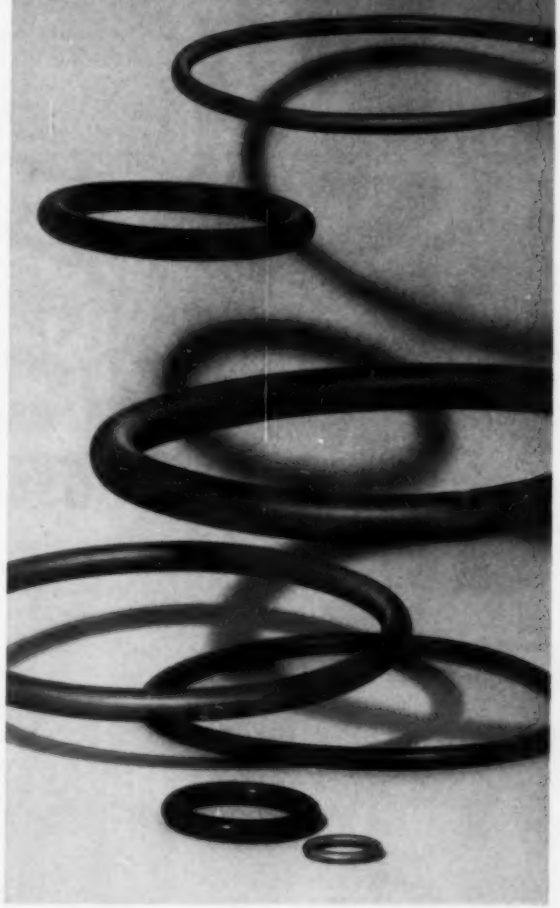
FOR EXCELLENCE IN SEALING RELIABILITY



Stillman has an enviable reputation for reliability in the development and production of O-Ring seals for military and industrial applications. The most difficult sealing requirements are met with ease because of Stillman's long years as sealing specialists for military projects where precision and reliability are prerequisites. Stillman O-Rings are produced in a complete range of sizes and compounds for both static and dynamic sealing. These O-Rings have found complete acceptability for the most critical applications. Unusual compounds such as silicone and Viton are standard in Stillman O-Rings. Still more exotic compounds are coming from Stillman laboratories each day, to meet the increasingly complex demands of present-day technology.

For further information, write to:

STILLMAN RUBBER COMPANY

CULVER CITY, CAL./CLEVELAND, O./ENGLEWOOD, N.J.

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POST SCRIPTS OF INDUSTRY

general manager of his company until 1959, when he became board chairman and chief executive officer. He was a graduate of the Culver Military Academy and Wharton School of Finance, Philadelphia. He served with the U.S. Air Corps in World War I.

T.A.L. Numatics holds conference

T.A.L. Numatics held its first international sales conference at Leighton Buzzard, England. In attendance was more than 20 T.A.L. men from this country and overseas. Visitors saw the production aspects of the organization.

Purolator appoints new director of engineering

Jules Kovacs, vice-president, has been named director of engineering of Purolator Products Inc. He will be responsible for all engineering activities, including services in the Technical Sales Dept., which he now directs. Kovacs joined Purolator in 1929 as a design engineer. Much of his experience was with automotive and industrial filters.

Kovacs

Fath

Fath named dir. mfg. at H-P-M

H-P-M Div., Koehring Co., Mount Gilead, Ohio, has promoted William J. Fath to director of manufacturing. Fath came to H-P-M in 1954 as production control manager. Before his new appointment he was works manager.

New distributors

Atlas Valve Co., Newark, will be represented in Oregon by *Thompson Instrument Service*, Portland.

Riggs Engineering Co., Ludlow, Kentucky, has been appointed as sales and service facility of Modernair Corp., San Leandro, Calif.

Livingston & Haven Inc., Charleston, distributes Hydra-ride accumulators made by Parker-Hydraulics Div., Parker-Hannifin Corp., Cleveland.

K. C. Mosier Co., Dayton, has become a distributor for Parker-Hannifin Corp. The company will sell cylinders, air control valves, industrial hose, and reusable hose fittings. Mosier has branches in Cincinnati, Columbus, Lima, Ohio, and Huntington, W. Va. Technical help will be given by Parker-Hannifin's W. E. Anderson and members of his staff, R. A. Beckert and R. L. Burleson.

Sturgis Valve & Fitting Corp., St. Louis, has been named by Racine Hydraulics & Machinery, Inc. as its sales representative in Missouri, Nebraska and Kansas, and southwestern Illinois and Iowa.

ON THE JOB...
with CROSS
HYDRAULIC CYLINDERS
Stay "on the job" with dependable, rugged Cross Hydraulic Cylinders. Like Cross customers everywhere, you too, will appreciate the fast, courteous, dependable service you get from Cross. Phone for speedy delivery on any quantity...quality-built to your specifications. Contact Cross Engineering Department, today!
■ RUGGED
■ DEPENDABLE
■ ECONOMICAL
CUSTOM DESIGNED CYLINDERS FOR EVERY APPLICATION
Try CROSS CYLINDERS in your operation... low cost, dependable, and trouble free.
Lowest-Priced Engineered Quality Cylinders Available..
trade mark of Quality in Hydraulic Cylinders...
HYDRAULIC CROSS CYLINDERS
CROSS MANUFACTURING CO.
LEWIS, KANSAS – PHONE EA 4-5525
WRITE • WIRE • PHONE...TODAY!!
Circle **24** on Reader-Service Card

Republic Mfg. Co. has signed the following as franchised distributors: *Air-Oil Power, Inc.*, Jacksonville, Florida, will cover the Jacksonville area. *Tri-State Mill Supply Co.*, Pine Bluff, Arkansas, will cover Arkansas, western Mississippi, and northern Louisiana.

Five dealers were appointed by H-P-M Div., Koehring Co., Mount Gilead, Ohio, to handle its line of hydraulic components: *Air Dreco*, Houston,—southern Texas; *Hydraulic Systems, Inc.*, Philadelphia,—Eastern Pa., Southern N. J., and Delaware; *Barker Instrument & Machine Co., Inc.*, Greenville, S. C., —North Carolina and South Carolina; *Hydra-Power Engineering*, Wayzata, Minnesota,—Minnesota and Western Wisconsin; *Industrial Air Controls, Inc.*, Fort Worth, Texas,—Oklahoma and Northern Texas.

F & S Distributors, Inc., Clifton, N. J., will be a franchise distributor of O-rings and rubber packings for E. F. Houghton & Co., Philadelphia.

Persingers Inc., Charleston, will be a distributor of air pressure regulators, filters and lubricators for Hannifin Co. of Des Plaines, Ill., a div. of Parker-Hannifin Corp. *Avels Sales & Engineering Corp.*, Indianapolis, will handle Hannifin cylinders, valves, regulators, filters, and lubricators. *Air-Oil Products Inc.*, Cleveland, will be franchised by the corporation's Fitting & Hose Div., Parker Hydraulics Div., Cleveland, and Hannifin Co., Des Plaines, Ill. A distributor for Parker accumulators and hydraulic valves will be *Ancar Engineering Inc.*, Chicago. The Parker Seal Co., Culver City, California, will make franchisements of all 105 distributors of its O-rings.

L & L Manufacturing Co., has appointed *Hughes Industrial Products, Buffalo*, to handle fittings throughout most of New York state, and *Ritchie Engineering Co.*, Minneapolis, to distribute products throughout the Dakotas, Minnesota, and in northwest Wisconsin.

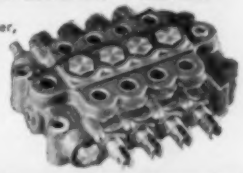
Continued on next page

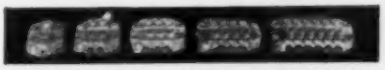
Circle **52** on Reader-Service Card

So Much Control . . .
So Little Space

HUSCO HYDRAULIC VALVES

HUSCO 4-Plunger, 45 G.P.M. Series 3200-SP Valve





- In ONE to SIX Plunger Designs
- For up to FOUR Control Positions
- Capacities from 3 to 185 G.P.M.

Other HUSCO features include:

- Power-Saving Pilot-Operated Relief Valve.
- Short Plunger Movement for more accurate control — at minimum effort.
- Check Valve Controlled circuits — Conventional or Parallel.
- Compact, precision-built for minimum space.
- Over 120 Standard Models — for unlimited modification to your needs.

Check HUSCO *First* for Hydraulic Control. Write for your copy of HUSCO'S "House of Ideas in Control Engineering" — or design assistance on your needs.

HUSCO

HYDRAULIC UNIT SPECIALTIES CO.
PUMPS • VALVES • CYLINDERS
P. O. Box 257-A, Waukesha, Wisconsin
West Coast Representatives
EASTMAN PACIFIC CO., Los Angeles, Calif.
ROY BOBBS AIR-DRAULIC CO., Portland, Ore.

BEST WAY TO SEAL HOLES!

LEE PLUG

Simply place plug in reamed hole. Drive in tapered pin until ends are flush. Controlled expansion causes grooves to "bite" into casting, assures a bone dry seal that withstands pressures up to 40,000 psi. Now widely used on aircraft and missiles, and for pumps, servo valves, regulators, etc.

*Pat. #2,821,323

LEE COMPANY
OLD SAYBROOK, CONN.

WRITE TODAY FOR COMPLETE ENGINEERING DATA

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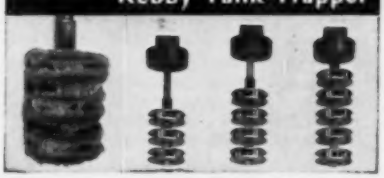
NEW MAGNETIC CLEANER for HYDRAULIC POWER UNITS the Kebby Tank-Trapper



★ Powerful Alnico V Magnets
★ Easy to Apply
★ Highest Active Area
★ Low Priced . . . Quick Delivery
★ Engineered for Power Concentration
★ No Moving Parts . . . No Maintenance

MEETS NEW J.I.C. HYDRAULIC STANDARDS

The Kebby Tank-Trapper is specifically designed to complete the protection of hydraulic systems against damage by iron particles worn off moving parts of various components. It picks up material missed by the filter and prevents premature filter loading. Expensive shut downs and service calls are drastically reduced. Write for Bulletin 1-500-59.

THE KEBBY COMPANY
2320 Custer Avenue Rockford, Illinois
Designers and Manufacturers of Magnetic Devices, Kebby Mite and Filtray Coolant Cleaners

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WATERMAN

Series 1617

D.C. 4-WAY
SOLENOID VALVES

High pressure
Low leakage
No dynamic seals

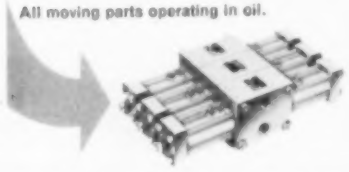
Complete range of types—closed-center, tandem, two-position configurations, etc.

3000 p.s.i. pressure—rated pressure may be applied to all ports.

Operate solenoids without flow or pressure.

Light and compact—weighs only 5 pounds complete.

All moving parts operating in oil.



Simple stacking or banking of any number of valves with standard kits. Allows you to add on later.

Send today for
new Catalog 2002

MEMBER NFPA

W-6110

WATERMAN HYDRAULICS CORPORATION

725 Custer Ave., Evanston, Ill.

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POST SCRIPTS OF INDUSTRY

Midwestern Rubber Co., Cleveland, *Shields Rubber Corp.*, Pittsburgh, and *Buffalo Rubber and Supply, Inc.*, have been appointed as distributors by Synflex Products Div. of Samuel Moore & Co., Mantua, Ohio.

Aircraft Products and Engineering Co., Atlanta, will distribute Linear products in the Atlanta trading area. *Electronic Manufacturers Assoc.*, Los Angeles, will export to the aviation industries and services in Africa, Greece, Portugal and Australia. *Packing Supply Co.*, Salt Lake City, has been assigned Utah, southwest Idaho, and western Wyoming. *Spencer Aircraft Industries, Inc.*, Seattle, will distribute Linear products in western Washington.

Gibson Engineering Co., Boston and Hartford, is New England representative for Hydro-Line Manufacturing Co., Rockford, Ill.

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Fall . . . *the original*

SPRING-LOADED

Wiper **Ring**

This patented closed joint ring provides squeeze - grip action, assuring complete contact on the rod at all times. Maintains uniform, continuous pressure on wiper edge. Rods are always clean in any temperatures.

Fall "CJ" Wiper Rings operate most effectively under extreme conditions of dust, glaze, oil, grit, powder, gases, sand, ice, etc. Available in diameters ½" through 13". For any commercial use. Used by military and aviation industry since 1944.

ACE PRODUCTS CO.

1820 N. 12th St. Toledo 1, Ohio
Est. 1935

How to get drier or cooler AIR or GASES

at low cost

NIAGARA *AERO* AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.

If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY
Dept. AH-2, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

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MARKET PLACE

ENGINEER WANTED

Recognized major manufacturer of pneumatic controls is looking for a man familiar with component design, with circuitry experience. Practical knowledge of foundry and shop practice desirable. Write Box 2161, HYDRAULICS & PNEUMATICS, stating experience and salary desired.

CONTROL SYSTEMS ENGINEER

For design analysis, development and application of fluid power control systems. Work in a creative environment with expanding opportunities. Must have degree in engineering, mechanical or electronic. Minimum of 4 to 5 years experience with control systems. Send resume to Personnel Manager, THE WEATHERHEAD COMPANY, 300 East 131st St., Cleveland 8, Ohio.

SALES MANAGER PROJECT MANAGER

I can design, test, tool and sell your Industrial or Mobile pumps, valves, or cylinders. Currently Sales Manager of world known pump and valve line. Experienced in all phases of industrial marketing from handling dealers to selling and engineering complete missile GSE packages. 12 years experience, will relocate. Company being sold, I want a responsible position to utilize my talents. $14,000 minimum. Write Box 2261, HYDRAULICS & PNEUMATICS

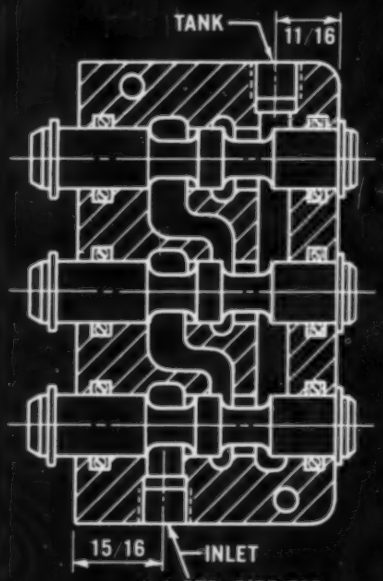
EXCLUSIVE REPRESENTATIVES

Manufacturer of industrial type, automotive approved, pneumatic valves has select territories open for representation. Send complete resume to Box 2361, HYDRAULICS & PNEUMATICS.

SALES ENGINEER WEST COAST

An outstanding position is open for a Mechanical Engineer with a proven successful sales background in the application of Industrial Hydraulic and Pneumatic Components used in general industry, missiles, space, and the atomic energy fields. Our company is the West's largest independent distributor representing only top manufacturers. Engineering Department of 40, also 35 in shop, backup Sales Department of 15 people. Branches located in Los Angeles, Portland, and Seattle. Salary plus commission. Excellent Profit Sharing Plan and Insurance benefits. Financial assistance if relocation is required. Forward resume in strict confidence. Eastern interviews will be held in February. Clarence J. Woodard, Vice Pres. THE RUCKER CO., Box 8158, Oakland, Calif. OLympic 3-5221

IMAGINATION FOR SALE!



BATCH LATCH

A "batch" of UH's creative engineering keeps the driver off the side rail of a batch truck and safely inside the cab. Power is harnessed from the main hoist cylinder and cement/aggregate batches are released in proper sequence—even if the wrong button is pushed. Whether your problem is complex or commonplace ... production run or prototype ... call or write us today.

UNIVERSAL HYDRAULICS

DIVISION OF HOLAN CORPORATION • 4500 BEIDLER ROAD • WILLOUGHBY, OHIO • WHITEHALL 2-4595

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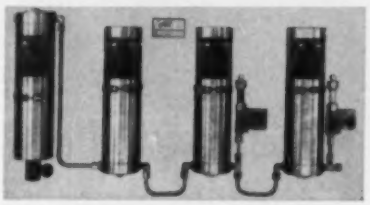
When water or oil in gases cannot be tolerated . . .



INSTALL ROBBINS dehydration equipment

Robbins Aviation offers you both disposable cartridge type and refrigeration type dehydration systems for practically all types of gases . . . equipment designed and built to rigid quality control standards to give you maximum satisfaction in efficient trouble-free performance.

Robbins equipment is used extensively for aircraft pneumatic systems, test laboratory equipment, mobile compressor trailers, hydraulic system purging, missile charging and pressurizing systems, for instrument, laboratory, and factory air, controlled atmospheres for brazing and heat-treating furnaces, etc. Mechanical filters, drier and purifier chambers, refillable and disposable cartridges, dewpoint indicators also available.

Fast, positive, economical removal of water or oil vapor and impurities

Pressures to	12,000 PSI
Safety Factor	4 to 1
Dewpoints to	−100°F
Oil Vapor Removed to . . . as low as 0.3 ppm/w	

Write today for complete information!

ROBBINS Aviation, Inc

Manufacturers of high quality valves and dehydration equipment

2350 E. 38th St., Los Angeles 58, Calif.
Ludlow 9-5221

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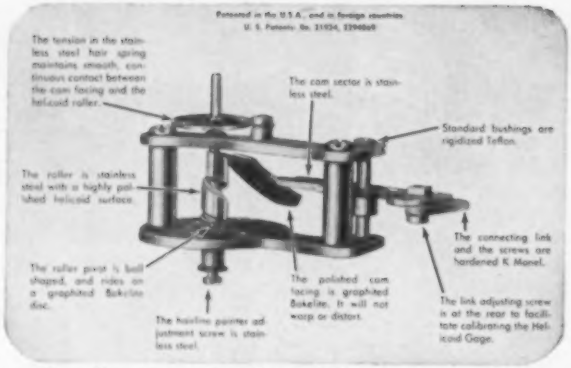
Patented in the U.S.A., and in foreign countries
U. S. Patents: No. 2,11024, 2,294,060
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is stainless steel.
Standard bushings are rigidized Teflon.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

Exclusive Helicoid movement provides *Sustained Accuracy* ...on the toughest jobs!

• Helicoid Gages have no gears, no teeth—wear is reduced to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Even when subjected to violent pressure pulsations or mechanical vibrations, Helicoid Gages *stay* accurate. Only Helicoid Gages provide *all* these advantages:

Sustained accuracy—Helicoid movements have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy. Conventional *geared* gages on the same test became useless after only 500,000 cycles.

Durability—Bourdon tubes won't stretch, leak or crack. Dial faces won't corrode or chip.

Wide selection—Gages are available for practically any application from tap water to acid. Gages include flanged and flangeless, round and square, in standard and flush-mounting models. Accessory equipment includes gage cocks, needle valves, siphons and snubbers.

NEW! Solid-Front Safe-T-Case Gage

This new Helicoid design diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming the back cover plate, which can then be replaced inexpensively.

Write for Catalog DH-65 for details on the complete line of Helicoid Gages

Distributed in Canada by Upton, Bradeen & James, Ltd.
Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Edmonton, Vancouver

HELICOID GAGES

ACCO

Helicoid Gage Division • American Chain & Cable Company, Inc.
929-H Connecticut Ave., Bridgeport 2, Conn.

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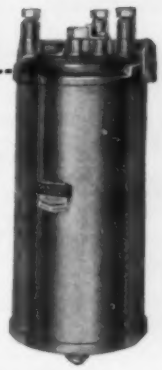

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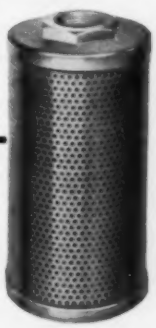

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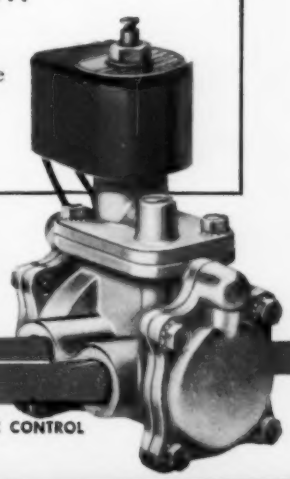

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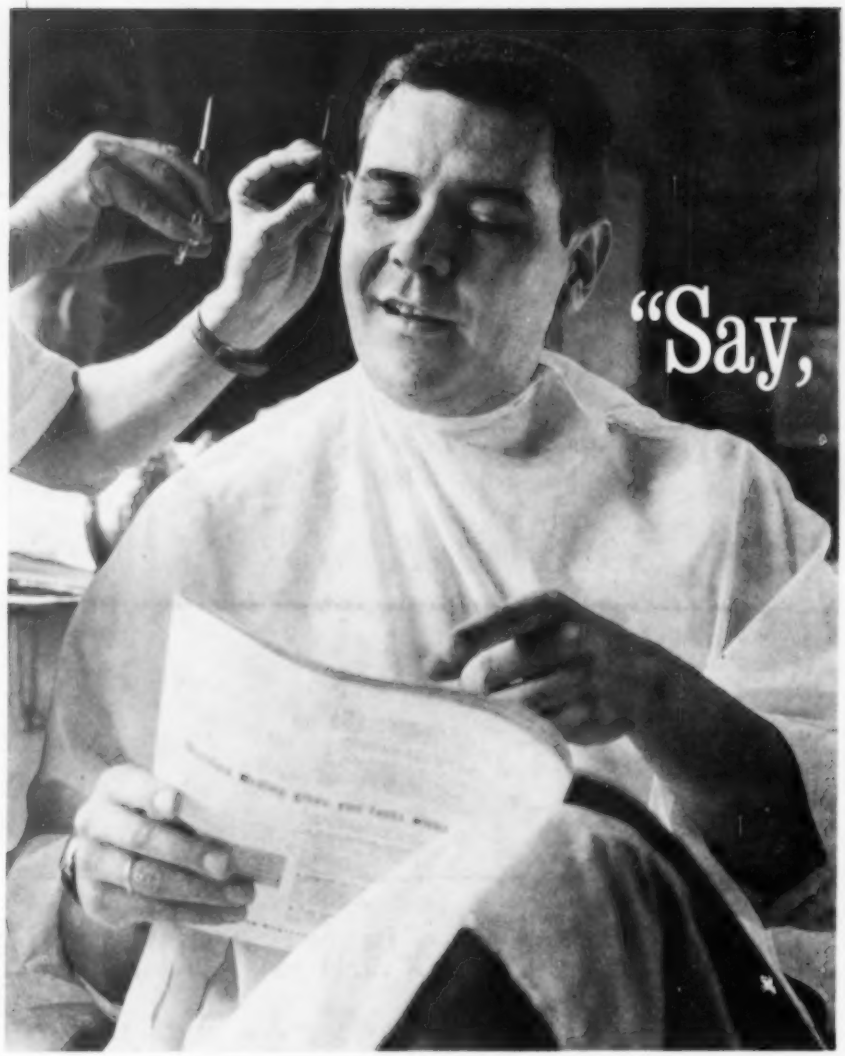

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